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Quality Requirements of Multinational Firms and Technological Change in Developing Countries

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Abstract

This paper explores how quality standards imposed by the subsidiaries of multinational enterprises on local suppliers can trigger the adoption of better techniques and processes in local intermediate goods industries thereby increasing the technological capability of the host country. The model includes the possibility that the local suppliers might improve quality of the product beyond the required threshold, a situation widely described by the empirical literature. The model shows that the decision to invest in product quality depends on the profitability of the venture, which in turn is a function of prices for final goods, intermediates content in final goods production as well as the cost of production and investment. If a host country is backward, which implies relatively high investment costs, investment liberalization might not bring any significant changes to the economy. The host government as well as multinational firms can improve the situation by providing technological and/or financial assistance.

Keywords: technological spillovers, foreign direct investment, quality improvement.

JEL Classification Numbers: F15, F21, F23, O31, O33.

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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 economies. First, there might exists technological spillovers from FDI in the form of observing, learning and imitating by local producers of more advanced technologies or better management practices, possessed by MNEs. (Mansfield and Romeo,1980; Blomstrom, 1986). In addition, multinational firms often help to augment the domestic human capital stock by providing substantial training to local employees (Hobday, 1995; Katz, 1987, Brash 1966). Finally, MNE subsidiaries can influence the productivity of local producers through linkages with domestic suppliers (backward linkages) and clients or distributors (forward linkages) (Lall,1980; McAleese and McDonald, 1987).

This paper addresses the issue of quality upgrading in developing countries as a result of quality standards imposed by MNEs on local suppliers of intermediate goods. A simple model developed below analyzes how quality requirements and increase in demand might induce local suppliers to invest in product quality, which in turn can lead to higher productivity in other industries. The decision to improve quality is influenced by the profitability of that venture, which in turn depends on the prices of final and intermediate goods, investment costs, local input content in the MNE production. In addition, the extent of technical support from the MNE and the ability to absorb knowledge influences the investment costs and the ability of the local supplier to innovate. The model includes a possibility that local suppliers can improve the product further by innovating.

The rest of the paper is organized as follows. Section 2 describes the related literature. Section 3 presents the model of linkages. Section 4 analyzes the effects of investment liberalization on the local economy. Section 5 concludes.

2. Related literature

Most theoretical studies on this topic analyze technological externalities that arise from the presence of MNEs modeling them as 'contagion effect' (Findlay, 1987, Das 1987, Baldwin, et.al. 1999). Recent papers by Fosfuri et.al. (2001) and Markusen (2001) address the issue of knowledge spillovers that occur when local employees trained by a multinational firm leave the company and work for a domestic enterprise. Some work has been done on modeling linkages between multinational firms and local producers. Particularly, Rodrigues-Clare (1996) examines the influence of the linkage effect on wages, variety of intermediate inputs produced within the economy and economic development of the host country. Markusen and Venables (1997a, 1997b) examine the interaction between the competition effect, which refers to substitution of domestic for multinational production in the downstream industry, and the linkage effect, which refers to increase in demand for local intermediates. The work below highlights another novel channel of technological improvements in the form of quality upgrading in the upstream industries in developing countries.

The empirical evidence on improved performance of local producers as a result of quality requirements imposed by multinational firms is extensive. Katz (1987) states that foreign MNCs operating in Argentina forced their domestic suppliers to adopt productive processes and techniques used by the suppliers of their main firms in their country of origin. Watanabe (1983a) notes complaints from small local suppliers in the Philippines about the tough requirements on both product characteristics and prices. Hobday (1995) describes that local suppliers in East Asia were supposed to produce intermediate inputs of the highest quality at the lowest price. If one firm failed to meet expectations, the foreign buyer could switch to another eager supplier. Brash (1966), in his study of the relationship between General Motors and its Australian local suppliers, points out the strict control from the multinational firm over the quality of the intermediate goods bought from the domestic producers. Surprisingly, compliance with the quality standards had led to a better performance of the local suppliers in other unrelated operations.

The most remarkable phenomena described in those case studies is that increased demand for local production could induce local suppliers to invest in the development of better products and processes. Katz (1987) shows that domestic suppliers in a number of Latin American countries would often redesign parts and components to increase resistance and improve performance. Lall (1980) describes that in India one of the projects by domestic supplier was so successful that the MNE subsidiary even tried to persuade their parent to adopt it at home. Even more remarkable examples can be found in the case studies of East Asian economies, where local firms started by supplying parts to MNEs in electronics, bicycle, sewing machine industries, then later became independent in creating new designs and new products. Some of them even took over the whole industry and learned to export directly into Western markets (Hobday, 1995). The model below shows how expanding demand for the domestic production can lead to local innovations.

3.1 The basic model

Consider a small developing country that trades final goods with the rest of the world and that can produce a simple composite good Y (such as clothes or food) and a low-tech good

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 imported or can be produced domestically by a foreign subsidiary of a multinational firm (hereafter the MNE). If the country decides to import good Q_m, imitation is impossible because of the complexity of the good. However, if the MNE produces it within the country, it can search for local intermediate inputs and establish a linkage with a local supplier. In that case, the local supplier chosen by the MNE might have to improve quality of the intermediate good to comply with the required quality standards.[3] The intermediate good of the improved quality can also be supplied to the domestic downstream producer.[4] The MNE can choose to import intermediates from its headquarters at some transfer price $\overline{p}$. I assume that, in the absence of demand from the MNE, the local producer faces a low domestic demand and high investment costs. Hence, it chooses to produce low-quality intermediates only.[5]

[1] I assume that goods Q_d and Q_m are not related. For example, increase in the demand for computers does not influence the demand for calculators.

[2] One reason why intermediates cannot be exported is high marketing costs. (see Hobday, 1995). It is necessary to have knowledge about design, packaging, product quality to link with the final buyers in developed economies. On the other hand, imports of intermediates can be prevented by local governments, in an attempt to protect local producers from the world competition (see Moran, 1995). Similar assumption is used by Markusen and Venables (1997a), Faini (1984), Rodrik (1995). Markusen and Venables argue that to the extent that intermediates are not perfectly freely traded the qualitative results are the same as with non-traded intermediates. Faini points to the possibility that intermediates can embody some non-traded producer services. Rodrigues-Clare (1996) argues that if intermediates are specialized inputs, the firm might be the only producer of them.

[3] Alternatively, instead of allowing multinational production the government might set up trading companies to facilitate export of goods which satisfy world quality standards abroad. However, it might require huge marketing costs.

[4] Intermediates x_i supplied to the MNE and to the domestic firm can be considered as two different goods with the same marginal cost of production. However, if the local producer improves quality of the intermediate good supplied to the MNE, quality of the good supplied to the domestic firm can be improved with no additional cost.

[5] The model can be easily extended to a less interesting case in which the local supplier already produces goods that satisfy quality standards.

3.2 Basic notation[6]

Q_d	quantity of low-tech good produced by the domestic producer
Q_m	quantity of high-tech good produced by the MNE
P_d	price of the final good produced by the local firm
P_m	price of the final good produced by the MNE
Π_d	profit of the domestic final good producer
Π_m	profit of the MNE
x_i^d	local producer's demand for intermediate inputs
x_i^m	MNE demand for intermediate inputs
p_i	price of the intermediates
$\overline{p}$	transfer price of the intermediates
π_d	profit of the upstream producer from supplying the domestic firm
π_m	profit of the upstream producer from supplying to both the domestic firms and the MNE
λ_i	quality of the intermediate inputs
$\overline{\lambda}$	threshold level of quality required by the MNE
i	effort level invested in quality improvements by the local supplier
$\bar{i}$	effort level necessary to achieve threshold level $\overline{\lambda}$
f	investment cost of the local supplier per unit of effort
c	marginal cost of producing intermediate inputs

[6] Note that upper case letters in notations correspond to the final goods producers, while low case letters correspond to the intermediate goods producer.

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, λ_i, of the intermediate product. I denote by $\lambda_1 = 1$ the lowest quality of the good, which can be improved by investing effort i to obtain quality level λ_i. Particularly assume that $\lambda_i = \sqrt{i}$, where $i \geq 1$. Quality λ_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 λ_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 higher quality intermediates generate higher output, so if different quality intermediates are available at the same price, the producer will always want to acquire the latest quality intermediates. Since the country is small and open to trade in final goods, the domestic downstream producer faces price P_d for his product, which includes the impact of trade barriers. Its profit function is expressed as

$$\Pi_d = P_d Q_d - p_i x_i^d \tag{2}$$

where p_i is price of intermediates.

Substituting (1) into (2) yields the profit function in terms of the intermediate input

$$\Pi_d = \frac{1}{\alpha} P_d (\lambda_i)^{1-\alpha} (x_i^d)^{\alpha} - p_i x_i^d \tag{3}$$

The producer maximizes (3) with respect to x_i^d taking the price of the intermediates p_i as given.

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[7] For the sake of convenience letter i is used to denote both the amount of effort and the quality level subscript of the intermediate good, since effort i determines the quality λ_i. For example, investing 2 units of effort results in upgrading quality to $\lambda_2 = \sqrt{2}$

The first-order condition for the problem is given by

$$\frac{\partial \Pi_d}{\partial x_i^d} = P_d \lambda_i^{1-\alpha} (x_i^d)^{\alpha-1} - p_i = 0 \tag{4}$$

The solution to (4) represents the domestic demand for intermediates, which is an increasing function of quality λ_i.:

$$x_i^d = \lambda_i \left(\frac{P_d}{p_i} \right)^{\frac{1}{1-\alpha}} \tag{5}$$

The MNE has an analogous production function

$$Q_m = \begin{cases} \frac{1}{\beta} \lambda_i^{1-\beta} (x_i^m)^\beta & \text{for } \lambda_i \geq \overline{\lambda} \\ 0 & \text{otherwise} \end{cases} \tag{6}$$

where $0 < \beta < 1$ and x_i^m are intermediates of some particular quality level $\overline{\lambda}$ or higher. The parameter β represents the content of intermediates in the production of the final good. In case the MNE buys intermediate inputs from the local suppliers, higher β means higher demand for the local product and therefore a higher benefit to the host economy. As was stated above, there is a threshold quality level $\overline{\lambda}$ of the intermediate product required by the MNE. The low quality intermediates originally produced by the local supplier can not be used by the multinational firm.

The MNE maximizes the following profit function:

$$\Pi_m = P_m Q_m - \overline{p} x_i^m \tag{7}$$

Substituting the expression for output, (6), into (7) yields profits of the MNE as a function of the intermediate inputs:

$$\Pi_m = \frac{1}{\beta} P_m (\lambda_i)^{1-\beta} (x_i^m)^\beta - \overline{p} x_i^m \tag{8}$$

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 ($\lambda_i \geq \overline{\lambda}$), 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.

[8] ***f*** includes payments to the R&D personnel, training costs, etc. *f* will be higher for countries with low education level and technical skills and vice versa. The MNE can lower investment costs *f* by providing training, technical and financial assistance. The government can also influence the investment cost by subsidizing education, organizing training for workers etc.

[9] The ability of the intermediate producer to choose price p_i stems from the non-tradability of intermediate inputs.

Substituting in equation for domestic intermediates demand (5) into (11) will yield

$$\pi_d = \lambda_i (p_i - c)\left(\frac{P_d}{p_i}\right)^{\frac{1}{1-\alpha}} - f \cdot i \tag{12}$$

When the upstream producer chooses to produce the basic quality intermediates, λ_1, (12) can be rewritten as

$$\pi_d = (p_i - c)\left(\frac{P_d}{p_i}\right)^{\frac{1}{1-\alpha}} - f \tag{13}$$

Maximizing (12) with respect to p_i yields the following first-order condition:

$$\frac{\partial \pi_d}{\partial p_i} = \lambda_i \left[\left(\frac{P_d}{p_i}\right)^{\frac{1}{1-\alpha}} + (p_i - c)\frac{1}{\alpha - 1}\left(\frac{P_d}{p_i}\right)^{\frac{1}{1-\alpha}} p_i^{-1}\right] = 0 \tag{14}$$

The optimal price obtained from (14) is

$$p_i = \frac{c}{\alpha} \tag{15}$$

It is a constant, which implies a constant mark up. Substituting optimal price (15) into (12) yields profit as a function of the exogenous variables, quality, and the effort level

$$\pi_d{}^* = \lambda_i (1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} - fi \tag{16}$$

Denote the value of profits inclusive of fixed investment cost when the basic quality intermediates are produced as V_d

$$V_d = (1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} \tag{17}$$

where V_d reflects the profitability of supplying the domestic firm. In other words, for each quality level the value of profit will be higher, the higher is the V_d. Now (16) can be rewritten

as $$\pi_d{}^* = \lambda_i V_d - fi \tag{18}$$

When basic quality intermediates are produced, $\pi_d{}^* = V_d - f$.

Maximizing (18) with respect to effort level i will yield the following first order condition:

$$\frac{\partial \pi_m}{\partial i} = \frac{1}{2\sqrt{i^*}} V_d - f \le 0 \qquad \text{where } \; i \ge 1 \tag{19}$$

Consider the internal and corner solutions separately.

(I) If $\frac{1}{2\sqrt{i^*}} V_d - f = 0$ then $i^* = \left(\frac{V_d}{2f}\right)^2 > 1$ (20)

This case corresponds to an internal solution and holds when $V_d > 2f$. The producer will find it profitable to produce intermediates of higher quality than basic. However, as was stated above, under the assumption of low demand and high investment costs (both of which are not unusual in developing countries) profit maximizing production entails a quality below world standards ($\lambda^* < \bar{\lambda}$). This implies that $i^* < \bar{i}$, or $V_d < 2f\sqrt{\bar{i}}$. For V_d these two conditions result in a range: [$2f;2f\sqrt{\bar{i}}$], which corresponds to a quality $1 \le \lambda^* < \bar{\lambda}$. Hereafter, I will refer to this level of quality as *intermediate quality*. All the different cases (the discussion of the rest of them follows) are depicted in Table 1. The described above case is depicted in the top panel of the table. Substituting in the expression for optimal effort level i^*, (20), into the profit function (18) yields the maximum profit for this range of V_d

$$\pi_d^* = \frac{V_d}{2f} V_d - f\left(\frac{V_d}{2f}\right)^2 = \frac{V_d^2}{4f} \tag{21}$$

Alternatively, substituting in for V_d yields the expression for π_d^* in terms of the exogenous variables and the parameters of the model:

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

(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
- $i^*=1$, if $\pi_d^* > 0$
- No production, if $\pi_d^* < 0$;

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_i. In that case the local supplier of intermediate inputs will 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: $\lambda_i = \sqrt{i}$, where $i \geq \overline{i}$, 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

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

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 both final goods producers and improve quality above the required threshold. In Case 2 the upstream producer will improve quality from intermediate level to only the required threshold if he supplies both final goods producers. In Case 3 the producer will improve quality of the good from the lowest level to the one higher than required by the MNE. Cases 5 and 6 show how the presence of the MNE can commence upstream industry production.

Different values of the exogenous parameters influence the profitability functions V_d and V_m, which in turn determine different equilibrium outcomes. I illustrate the results in a parameter space in two variables V_d and V_m in Figure 1. As a reminder, V_d reflects the profitability of supplying the domestic downstream producer, while V_m reflects the profitability of supplying the MNE. Consider first the situation when the producer decides to innovate. The following conditions should hold

$$i^{**} > \bar{i} \quad (35)$$

$$\pi_m^* > \pi_d^* \quad (36)$$

$$\pi_m^* > 0 \quad (37)$$

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

$$V_d + V_m > 2f\sqrt{\bar{i}} \quad (38)$$

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

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

$$i^{**} \leq \bar{i} \quad (41)$$

$$\pi_m^* > \pi_d^* \quad (42)$$

$$\pi_m^* > 0 \quad (43)$$

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

$$V_d + V_m \le 2f\sqrt{\bar{i}} \tag{44}$$

$$(V_m + V_d)\sqrt{\bar{i}} - f\cdot\bar{i} \ge \begin{cases} \dfrac{V_d^2}{4f} & V_d \in [\,2f;\ 2f\sqrt{\bar{i}}\,] \quad (45) \\ V_d - f & V_d \in [\,f;\ 2f\,] \quad (45') \\ 0 & \quad (46) \end{cases}$$

The solution to inequality (44) corresponds to the area below line AB in the Figure 1. Inequalities (45) and (45') are satisfied above boundaries DB and LD respectively, and the area that satisfies constraint (46) is above line KL[11]. Therefore, the region ABDLK supports the *quality improvement case*. In comparison to the innovation case, in this situation not only the additional demand, but also the quality requirements from the MNE are important for the decision to improve quality. Without those requirements, the local supplier would produce the lower quality good.

In case the upstream producer decides to supply the domestic downstream producer only the following conditions should hold: $\pi_m^* < \pi_d^*$ and $\pi_d^* > 0$. This is equivalent to

$$V_m < \begin{cases} \dfrac{V_d^2}{4f\sqrt{\bar{i}}} - V_d + f\sqrt{\bar{i}} & V_d \in [\,2f;\ 2f\sqrt{\bar{i}}\,] \quad (47) \\ -V_d\left(1 - \dfrac{1}{\sqrt{\bar{i}}}\right) + f\left(\sqrt{\bar{i}} - \dfrac{1}{\sqrt{\bar{i}}}\right) & V_d \in [\,f;\ 2f\,] \quad (48) \end{cases}$$

$$V_d > f \tag{49}$$

The region which satisfies these inequalities is region *f*LDB in the Figure 1.

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[11] Lines KL and LD intersect at point L which satisfies: $V_d = f$. To get the point solve for: $f\sqrt{\bar{i}} - V_d \ge -V_d\left(1 - \frac{1}{\sqrt{\bar{i}}}\right) + f\left(\sqrt{\bar{i}} - \frac{1}{\sqrt{\bar{i}}}\right)$. The corresponding values for V_m at points L and D are $f(\sqrt{\bar{i}} - 1)$ and $\frac{f}{\sqrt{\bar{i}}}(\sqrt{\bar{i}} - 1)^2$ respectively. See Appendix A for derivations

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, $\bar{p}$, determine the value of V_m and therefore the position of the firm in the vertical dimension on the graph. Appendix B shows that a lower marginal cost, *c*, higher final goods prices, P_d and P_m,[12] and higher intermediates content [13] increase profits of the upstream producer and increase the extent of quality improvements and innovation.

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[12] Lall (1981) shows that the period of heavy protection in Indian automotive industry did promote considerable technological learning in some enterprises and contribute to social welfare.

[13] Lall (1981) points out that host countries governments try to actively encourage the growth of a supplier industry by imposing local content requirement on multinational firms.

4. The effects of the presence of multinational enterprise

Now consider the impact of the presence of the MNE. Before the MNE enters the host country, the position of the local supplier is somewhere on the horizontal axis ($V_m = 0$) in Figure 1. For example, point S corresponds to high profits relative to the fixed costs, point M corresponds to lower profits, and point N to a case in which there is no production of intermediates because fixed costs f are larger than the revenue V_d. The presence of the multinational enterprise creates additional demand, which results in additional profits ($V_m > 0$) if the local supplier complies with the quality standards. This will move points S, M, and N in the upward direction. The extent of the movement depends on the value of V_m which in turn is a function of exogenous parameters, as was shown above. Consider the effects of a multinationals' entry for different initial situations. At point S, the innovation costs are low relative to the profits earned. The position corresponds to the production of a good of intermediate quality. This case might be associated with a large supplier, which possesses the adequate knowledge of the quality improving technology. However, due to low demand, the supplier finds it profitable not to invest much in quality. This producer will easily comply with the quality standards when demand for intermediates will increase. He will also innovate more. If the industry is originally at point M, the profits are lower and investment costs are higher than at point S. This case might be associated with a more competitive intermediate industry. The equilibrium outcome depends on the profits earned from supplying the MNE. Below the section LD, the additional profits from supplying the MNE are not enough to induce the intermediate goods producer to invest in quality. Thus, he will continue to produce the basic quality intermediates. At point M', the intermediate producer will only improve quality up to the threshold level, while a larger increase in profits (point M'') induces innovation. Points S' and M'' in the graph show linkage effects. The presence of the MNE creates a higher demand for the intermediate inputs, so the upstream industry expands. This is called *a backward linkage effect*. In turn, a higher quality of the intermediates allow the MNE to produce more of the final good - this expands the downstream industry. This effect is called *a forward linkage effect*. The benefits, which are spilled-over to the domestic downstream industry constitute the externality created by the presence of the MNE.

Now consider point N in the graph. It corresponds to “no production” originally. This position might be associated with a very backward country with relatively high investment costs. At point N' the intermediates demand from the MNE is not enough to commence the production in the upstream industry since costs are still high relatively to the revenue earned. So, at point N' investment liberalization does not have any positive impact on the economy. However, higher demand for intermediate inputs from the MNE may not only start the intermediate industry (point N''), but also induce local supplier to innovate (point N'''). This case is consistent with the empirical studies of East Asia (Hobday, 1995). Similar results were found by Markusen and Venables (1997). Everywhere above the section KLDB spillovers are present because the MNE is not able to extract all the gains from the quality improvements in the local economy.

To see how the profit of the domestic downstream producer will change with improvements in quality of intermediates, substitute (14) for price of intermediates and (5) for intermediates demand into its profit function (3)

$$\prod_d = \frac{1}{\alpha} P_d \lambda_i^{1-\alpha} \lambda_i^{\alpha} \left(\frac{\alpha P_d}{c} \right)^{\frac{\alpha}{1-\alpha}} - \frac{c}{\alpha} \lambda_i \left(\frac{\alpha P_d}{c} \right)^{\frac{1}{1-\alpha}} = \lambda_i \left(\frac{\alpha}{c} \right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} \tag{50}$$

As can be seen the profit of the domestic final producer will rise with increase in quality of intermediate inputs. This is the externality from the presence of the MNE to the domestic final producer, described above.

The profit of the upstream producer if he supplies to both final producers is

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

As can be seen higher quality λ_i generates higher profits. I simulate the behavior of the profit functions of the downstream producer, Π_d, and the upstream producer, π_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):

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

Obviously, the MNE also gains from higher quality of intermediate goods.

Consumer surplus does not change since the economy is open and prices P_d and P_m are given. However, if wages are increasing with employment, then improvements in the quality of intermediate good can lead to expansion of upstream and downstream industries and benefit both skilled and unskilled labor, especially in a particular case when the presence of the MNE commence the upstream industry.[14]

5. Conclusion.

This paper explores how quality standards imposed by the subsidiaries of multinational enterprises on local suppliers can trigger the adoption of better techniques and processes in local intermediate goods industries thereby increasing the technological capability of the host country. The model includes the possibility that the local suppliers might improve quality of the product beyond the required threshold, a situation widely described by the empirical literature.

The model shows that the decision to invest in quality improvements depends on the profitability of the venture, which in turn is a function of exogenous parameters. Particularly, higher prices for final goods, high intermediate content in final goods production as well as lower costs of production and investment promote improvements in quality. If a host country is very backward, which implies relatively high investment costs, investment liberalization might not bring any significant changes to the economy. The host government as well as the MNE can improve the situation by providing technological and/or financial assistance.

[14] Another aspect not captured in this model is the extent of substitution between the good produced by the domestic producer Q_d and the good produced by the MNE Q_m. In case the expansion of MNE production crowds out domestic production of Q_d the welfare effects of FDI are ambiguous, since the profit of domestic producer will decrease. The evidence of that can be found in Aitken and Harrison (1991) who examined Venezuelan manufacturing industry between 1976 and 1989 and concluded that the effect of FDI on the productivity of upstream local firms is generally negative. MNE divert demand from domestic inputs to imported inputs, which means that the local suppliers are not able to benefit from potential economies of scale.

6. References

1) Aitken, B. and A.Harrison (1991), "Are There Spillovers From Foreign Direct Investment? Evidence from Panel Data for Venezuela", mimeo, MIT and the World Bank, November.

2) Baldwin, R.E., Braconier, H. and R. Forslid (1999), "Multinationals, Endogenous growth
and Technological Spillovers:Theory and Evidence".Draft.

3) Behrman, J. and H. Wallender (1976), "Transfer of Manufacturing Technology within Multinational Enterprises", Cambridge, Mass.; Ballinger.

4) Blomstrom, M. (1991), "Host Country Benefits of Foreign Investment", in D.G. McFetridge, ed., Foreign Investment, Technology and Economic Growth, Toronto and London; Toronto University press.

5) Blomstrom, M. and Ari Kokko (1995), "Multinational Corporations and Spillovers: A Review of the Evidence", Stockholm School of Economics Working Paper.

6) Brash, D.T. (1966), "American Investment in Australian Industry," Cambridge, Mass.; Harvard University Press.

7) Das, S. (1987), " Externalities, and Technology Transfers through Multinational Corporations: A Theoretical Analysis", Journal of International Economics, Vol. 22, 171-182.

8) Ethier, W.J. and J.R. Markusen, (1991), "Multinational Firms, Technology Diffusion and Trade." NBER working paper No.3825

9) Faini, R., 1984, "Increasing returns, non-traded inputs and regional development," Economic Journal 94, 308-323.

10) Findlay, R.(1978), "Relative Backwardness, Direct foreign Investment, and the Transfer of Technology: A Simple dynamic model", Quarterly Journal of Economics, Vol. 92, 1-16.

11) Fosfuri, A., Motta, M. and T. Ronde (2001), "Foreign Direct Investment and Spillovers through Workers' Mobility". Journal of International Economics, 53, 205-222.

12) Grossman, G.M. and A. Helpman, (1991), "Innovation and Growth in the Global Economy,"
Cambridge, MIT Press.

13) Hobday, M. (1995), "Innovation in East Asia: The Challenge to Japan", Aldershot: London.

14) Hymer, S. (1960), "The International Operations of national Firms: A Study of Direct Investment", unpublished PhD Thesis, Massachusetts Institute of Technology.

15) Katz, J.M. (1987), Technology generation in Latin American Manufacturing Industries, New York; St.Martin's Press.

16) Koizumi, T. and K.J. Kopecky (1977), "Economic Growth, Capital Movements and the International Transfer of Technical Knowledge", Journal of International Economics, Vol. 7, 45-65.

17) Kokko, A. (1994), Technology, Market Characteristics, and Spillovers. Journal of Development Economics. 43. 279-293.

18) Lall, S. (1980), "Vertical Interfirm Lankages in LDCs: An Empirical Study", Oxford Bulletin of Economics and Statistics, Vol. 42, 203-226.

19) Lall, S. (1981), Developing Countries as Exporters of Technology. London: Macmillan.

20) Markusen, J.R. (2001), Intellectual Property Rights, and Multinational Investment in Developing Countries". Journal of International Economics, 53, 189-204.

21) Markusen, R.J. and Venables A.J. (1997), "Foreign Direct Investment as a Catalyst for Industrial Development", NBER working paper 6241.

22) Markusen, J.R. and A.J.Venables (1997), "The impact of Foreign investment on Host Economies". European Bank for Reconstruction and Development.

23) McAleese, D. and McDonald (1978), "Employment growth and Development of Linkages in Foreign-Owned and Domestic manufacturing Enterprises", Oxford Bulletin of Economics and Statistics, Vol.40, 321-339.

24) Pack, H. and Westphal, 1986, Industrial Strategy and Technological Change: Theory versus Reality, Journal of Development Economics, 22, 87-128.

25) Porter, M.E. The Competitive Advantage of Nations. New York. The Fall Press, 1992.

26) Rodriguez-Clare, A. (1996), "Multinationals, Linkages, and Economic Development", American Economic Review, 86, 852-873.

27) Rodrik, D., 1996, Coordination failures and government policy: A model with applications to East Asia and Eastern Europe. Journal of International Economics, v 40.

28) Reuber, G.L., with H. Crookell, M. Emerson, and G.Gallais-Hamonno (1973), Private Foreign Investment in Development, Oxford; Clarendon Press.

29) Venables, A. (1996) "Trade policy, cumulative causation and industrial development", Journal of Development economics, 49, 179-197.

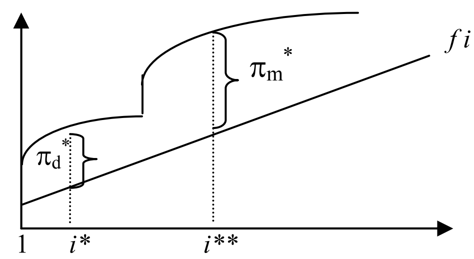
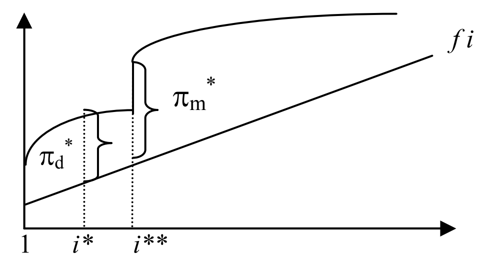
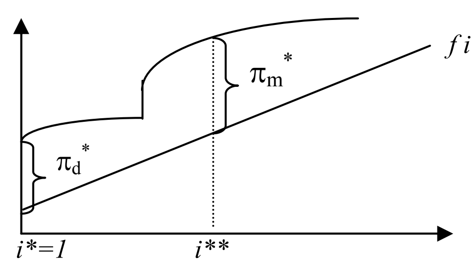
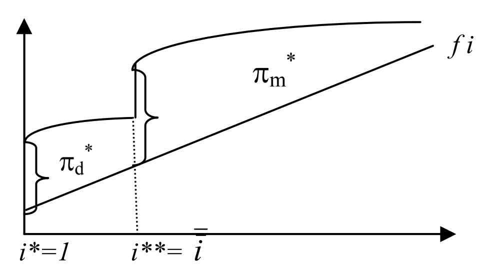
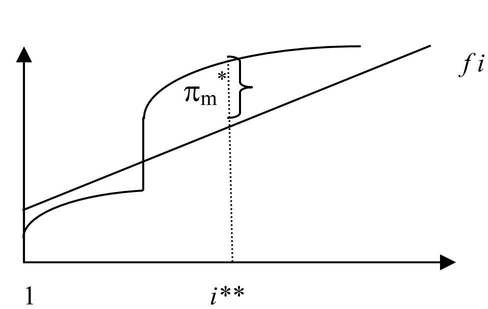
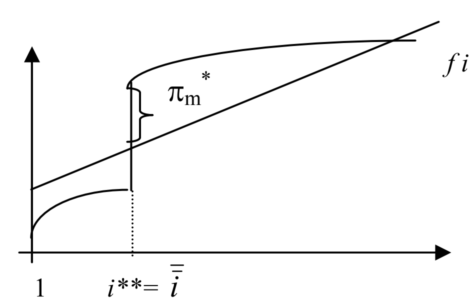
30) Wang, Y. and M. Blomstrom (1992), Foreign Investment and Technology Transfer: A Simple Model", European Economic Review, Vol.36, 137-155.

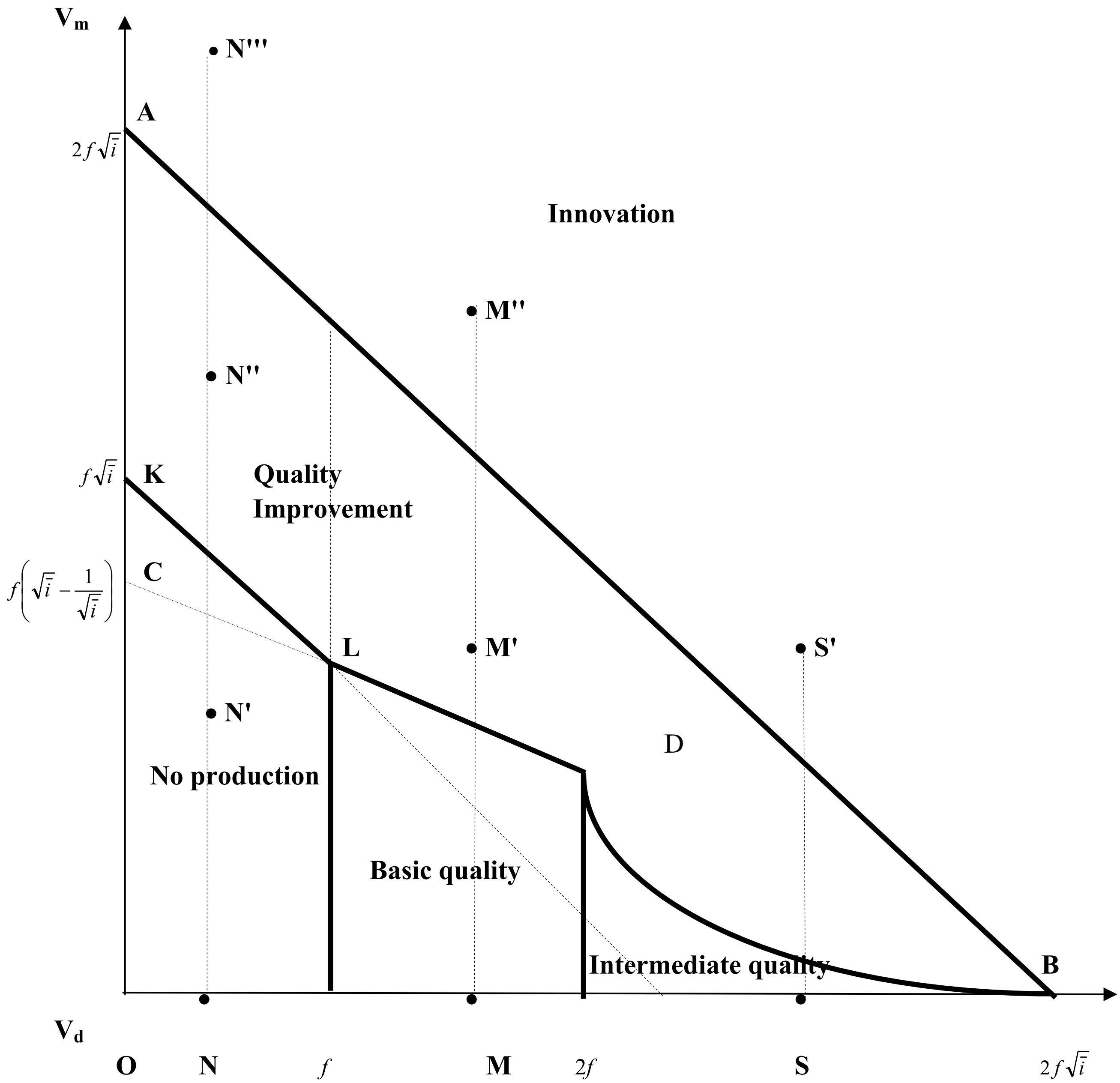
31) Watanabe, S (1983a), Technical Co-operation between Large and Small Firms in the Filipino Automobile Industry", in S. Watanabe, ed., Technology Marketing and Industriealization: Linkages between Small and Large Enterprises, New Delhi; Macmillan.

32) Watanabe, S. (1983b), "Technological Linkages through Subcontracting in Mexican Industries", in S. Watanabe, ed., Technology Marketing and Industrialization: Linkages between Small and Large Enterprises, New Delhi; Macmillan.

33) Wilson, Patricia A. Exports and Local Development: Mexico’s new Maquiladoras. Austin: University of Texas press, 1992

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  $\pi_d^* = \frac{V_d^2}{4f}$ $\pi_m^* = \frac{(V_d + V_m)^2}{4f}$	Case 2  $\pi_d^* = \frac{V_d^2}{4f}$ $\pi_m^* = \bar{\lambda}(V_d + V_m) - f\bar{i}$
$f<V_d<2f$ $\lambda^* = 1$ **Basic quality**	Case 3  $\pi_d^* = V_d - f$ $\pi_m^* = \frac{(V_d + V_m)^2}{4f}$	Case 4  $\pi_d^* = V_d - f$ $\pi_m^* = \bar{\lambda}(V_d + V_m) - f\bar{i}$
$V_d < f$ **No production**	Case 5  $\pi_d^* = 0$ $\pi_m^* = \frac{(V_d + V_m)^2}{4f}$	Case 6  $\pi_d^* = 0$ $\pi_m^* = \bar{\lambda}(V_d + V_m) - f\bar{i}$



<u>Figure 1</u>. The decision of the local supplier to invest in quality improvements

The decision of the local supplier to invest in quality improvements is depicted in terms of variables V_d and V_m, where :

$$V_d = (1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}} \qquad V_m = (\overline{p}-c)\left(\frac{P_m}{\overline{p}}\right)^{\frac{1}{1-\beta}}.$$

Higher value of V_d corresponds to the rightward movement and higher value of V_m corresponds to the upward movement. The next section shows how different parameters influence values of V_d and V_m.

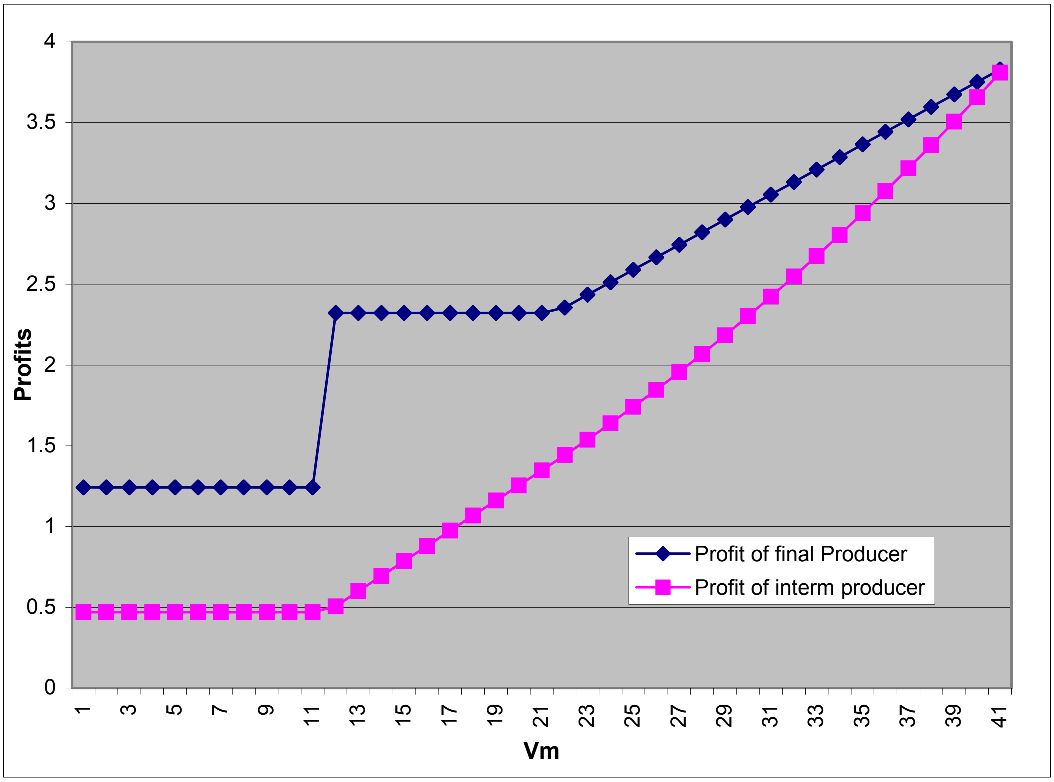


Figure 2. Profits of the domestic producers as a function of profitability V_m

Appendix A

Point D is an intersection of lines LD and DB.

LD: $V_m = -V_d\left(1-\frac{1}{\sqrt{\bar{i}}}\right)+f\left(\sqrt{\bar{i}}-\frac{1}{\sqrt{\bar{i}}}\right)$ (A1)

DB: $V_m = \frac{V_d^2}{4f\sqrt{\bar{i}}} - V_d + f\sqrt{\bar{i}}$ (A2)

Since they intersect at pt $V_d = 2f$, substitute this value into either (A1) or (A2):

(A1): $V_m = -2f\left(1-\frac{1}{\sqrt{\bar{i}}}\right)+f\left(\sqrt{\bar{i}}-\frac{1}{\sqrt{\bar{i}}}\right) = \frac{f}{\sqrt{\bar{i}}}[-2\sqrt{\bar{i}}+1+\bar{i}] = \frac{f}{\sqrt{\bar{i}}}[1-\sqrt{\bar{i}}]^2$

(A2): $V_m = \frac{4f^2}{4f\sqrt{\bar{i}}} - 2f + f\sqrt{\bar{i}} = \frac{f}{\sqrt{\bar{i}}}[-2\sqrt{\bar{i}}+1+\bar{i}] = \frac{f}{\sqrt{\bar{i}}}[1-\sqrt{\bar{i}}]^2$

Analogously, point L is an intersection of lines KL and LD.

KL: $V_m = f\sqrt{\bar{i}} - V_d$ (A3)

LD: $V_m = -V_d\left(1-\frac{1}{\sqrt{\bar{i}}}\right)+f\left(\sqrt{\bar{i}}-\frac{1}{\sqrt{\bar{i}}}\right)$ (A4)

Since they intersect at point $V_d = f$, substitute this value into either (A3) or (A4).

(A3): $V_m = f\sqrt{\bar{i}} - f = f(\sqrt{\bar{i}}-1)$

(A4): $V_m = -f\left(1-\frac{1}{\sqrt{\bar{i}}}\right)+f\left(\sqrt{\bar{i}}-\frac{1}{\sqrt{\bar{i}}}\right) = f(\sqrt{\bar{i}}-1)$

Appendix B

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

$V_d = (1-\alpha)\left(\frac{\alpha}{c}\right)^{\frac{\alpha}{1-\alpha}} P_d^{\frac{1}{1-\alpha}}$, therefore

$$\frac{\partial V_d}{\partial c} = -\left(\frac{\alpha P_d}{c}\right)^{\frac{1}{1-\alpha}} < 0 \qquad \text{(B1)}$$

$$\frac{\partial V_d}{\partial P_d} = \left(\frac{\alpha P_d}{c}\right)^{\frac{\alpha}{1-\alpha}} > 0 \qquad \text{(B2)}$$

Expression (B1) and (B2) imply that a lower marginal cost of production, *c*, and higher price for the domestic final good, P_d, (which can result from industry protection or higher demand) increase the profits of the intermediate goods producer and raise the desire to invest in quality (a rightward movement in the graph).

Analogously, recall from (21) that $V_m = (\overline{p}-c)\left(\frac{P_m}{\overline{p}}\right)^{\frac{1}{1-\beta}}$. Hence,

$$\frac{\partial V_m}{\partial c} = -\left(\frac{P_m}{\overline{p}}\right)^{\frac{1}{1-\beta}} < 0 \qquad \text{(B3)}$$

$$\frac{\partial V_m}{\partial P_m} = (\overline{p}-c)\overline{p}^{\frac{1}{\beta-1}} \frac{1}{1-\beta} P_m^{\frac{1}{1-\beta}-1} > 0 \qquad \text{(B4)}$$

$$\frac{\partial V_m}{\partial \beta} = (\overline{p}-c)\left(\frac{P_m}{\overline{p}}\right)^{\frac{1}{1-\beta}} \frac{1}{(1-\beta)^2} \ln\frac{P_m}{\overline{p}} > 0 \qquad \text{(B5)}$$

Equations (B3), (B4) and (B5) imply that a lower marginal cost, c, a higher price for final good, P_m, and a higher content of intermediates in the MNE production increase profit and therefore the extent of quality improvements (upward movement).