# Innovation, Technology Transfer and North - South Trade

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**Abstract**

*The paper describes a simple theoretical model to show the effect of (cost reducing) innovation by Northern firm in North-South trade and uses a simple game theoretic framework to show that the optimum Strategy by North as well as South depend on the cost as well as benefit of innovation and the patent regime offered by South.*

**Keywords** — *Innovation, Technology Transfer, Imitation, Loyalty payment, Export, Autarky, North-South Trade.*

## I. INTRODUCTION

In the last three decades the world has witnessed quite dramatic changes in the nature and intensity of competition among firms in the industrialized countries for the share of the market that had not expanded fast enough. Cut-throat competition in prices has been supplemented by cost reduction and product differentiation through continuous innovation. In industries where technological progress is rapid and risk of economic obsolescence is high, Research and Development (henceforth R&D) and innovation have been even more important for mere survival. However, there has been asymmetry in the R&D effort as well as the rate of successful innovations across countries which have resulted into high – technology exports in turn determining the pattern of specialization, trade and the distributions of gains from trade among the nations. The asymmetry in R&D effort is particularly pronounced across the developed and the developing countries.

Another important issue is the appropriation of the return from innovation which necessitates the granting of patents to successful innovators. An important role of the patent system is to enhance R&D investment by giving the innovator property right on its innovation. A stronger patent protection eliminates (or at least reduces) imitation and increases the innovator's return from innovation, thus encourages investment in innovation. It is common among empirical studies to find a net positive effect between IPR protection (measured by a system of patents, for instance) and innovation. In fact, the empirical evidence suggests a positive relationship between this kind of protection and innovation, despite certain characteristics of the sample, such as the type of countries in the study (for instance, the above result is significant mostly for low and high

income countries but not for middle income countries), may bring some bias into the analyses (for a detailed analysis of such differences see Azevedo et al., (2012) [1]. Under the current WTO (World Trade Organization) regime, one of the most debated issues is strengthening patent protection across the world and the debate gathered momentum due to the Dunkel proposal in connection with Trade Related Intellectual Property Rights (TRIPS). The basic argument goes as follows. If there is a weak (or no) patent protection, it allows more firms than only the original innovator to use technologies similar to the innovated technology. Hence, the original innovator does not get proper return from its R&D, which, in turn, reduces the innovator's incentive for R&D investment. However, a strong patent protection allows only the original innovator to use the innovated technology, and increases the innovator's incentive for R&D investment by increasing its return from R&D. The issue of patent protection is one of the most contentious issues in the context of technology transfer from the developed North to the developing South. The developed countries mainly the United States, European Community and Japan feel that the present system provides an inadequate protection to intellectual property rights (IPRs) and are interested in strengthening this protection in the world. The poorer countries, on the other hand, are against this protection, as it would increase the profits of the monopolistic Northern firms at the expense of their domestic consumers.

The quest for finding out the effects of patent protection in the developing countries on the innovation of the developed countries and social welfare has created a vast theoretical literature in recent decades. Chin and Grossman (1990) [2] studied the welfare implications of patent protection in a North-South trading environment. In their model, global patent protection stimulates innovation in the North and thus the North benefits from the patent protection in the South. Diwan and Rodrik (1991)[4] argue that when the North and South have different technological needs and tastes and the R&D resources are limited then the Southern patent protection might have a role in promoting the development of technologies appropriate to the South. In dynamic contexts, the issue of patent protection and its impact on the innovation rate and welfare are discussed by many authors (see Helpman (1993) [7], Grossman and Helpman (1991) [6], Segerstrom et al. (1990), [8]; Deardorff (1992) [3], Taylor (1994), [11]

Vishwasrao (1994), [12]. Fosfuri (2000) [5] analysed the mode of entry of Northern firms and the vintage of technology in terms of quality are influenced by the degree of patent protection in the recipient country. Sinha (2001, 2006) [9, 10] argue that the different modes of technology transfers (licensing or subsidiary) affect the R&D incentive and thereby the rate of innovation in the North. It is shown that under the licensing contract, no patent protection in the South is best for the South as it increases the innovation rate in the North, thereby leading to greater welfare in the South.

The present paper develops a simple model using a partial equilibrium framework to analyse the optimum policy of South, when innovation takes place by Northern firm and shows that as long as Northern firm continues to export "imitation" (if allowed) can be the best response of Southern firm, but if the Northern firm stops export then the southern firm may go for paying "loyalty" instead of going back to autarky. The paper is structured as follows. After a brief introduction, Section 2 presents the set up of the model. Section 3 concludes.

## II. THE MODEL

There are two firms, one in the North (exporter), the other in the South (importer). Both produce a good with identical constant marginal cost technology. The northern firm undertakes a deterministic R & D process to lower the production cost of the good. No R & D is conducted by the southern firm. Both firms continue to compete in the output market. Marginal costs are constant and denoted by c for each firm. There are increasing returns to research for the northern firm and a simple form of R & D function is chosen: an additional expenditure of R dollars (R>1) on one unit reduces its marginal cost by $R^2$ dollars. R & D results in a per-unit cost of $(c - R^2)$ for the northern firm. Demand is linear and given by P = a - Q, where P is the price of the good in world markets and Q is the total quantity sold by both firms.

Technology transfer can take place in two ways. The South may be able to imitate the cost reduction without licensing (through patent disclosure or reverse engineering alone) at some fixed cost M. In this case, it enjoys the same per-unit cost, c, as the northern firm and imitation would allow the southern firm to avoid any output-related payments stipulated by the licensing agreement. However, the southern firm may not be able to imitate unless the technology is licensed and in that case the Southern firm has to pay the loyalty.

### A. Pre Innovation

The profit functions in North and South are respectively,

$$\pi_N = P_S * Q_{NS} + P_N * Q_{NN} - c(Q_{NS} + Q_{NN}) \quad (1)$$

$$\pi_S = P_S * Q_{SS} - c(Q_{SS}) \quad (2)$$

The equilibrium outputs and Profits are respectively,

$$Q_{NS} = \frac{(a - c)}{3b} \quad (3) \qquad Q_{NN} = \frac{(a - c)}{3b} \quad (4)$$

$$Q_{SS} = \frac{(a - c)}{2b} \quad (5)$$

$$\pi_N = \frac{13(a - c)^2}{36b} \quad (6) \qquad \pi_S = \frac{(a - c)^2}{36b} \quad (7)$$

### B. Post Innovation

As per the assumption only Northern country firm conducts innovation and the technology transfer in South can take place in two ways: I) Imitation (without any loyalty payment) where the Southern firm may be able to imitate the cost reduction without licensing (through patent disclosure or reverse engineering alone) at some fixed cost M (which has been normalized to zero in the present model). In this case, it enjoys the same per-unit cost, as the northern firm.

II) Full loyalty payment where the Southern firm has to pay full loyalty (L=R) on each unit of production if it adopts new technology.

The northern firm makes its R & D decision in the first period, yielding a certain cost reduction. Once the innovation has been introduced, in the second period, the northern firm must decide whether to export the good to the southern market (depending on patent regime) and simultaneously the southern government has to decide whether to offer the patent protection or not.

1) *No technology transfer*: If the innovation takes place by Northern firm and the Southern firm does not follow the new technology (may be due to extremely strict patent law accompanied by too high loyalty rate), the output of Northern as well as Southern firm will be as follows.

$$Q_{NS}^0 = \frac{(a - c - 2R + 2R^2)}{3b} \quad (8)$$

$$Q_{SS}^0 = \frac{(a - c + R - R^2)}{3b} \quad (9)$$

$$Q_{NN}^0 = \frac{(a - R - (C - R^2))}{2b} \quad (10)$$

**Proposition 2.1:-**

i. *Without technology transfer, the output of Southern firm will decrease compared to pre-innovation output.*

Proof: - $Q_{SS}^0 < Q_{SS}$ as $R > R^2$

ii. *At the extreme situation there may be monopoly of Northern firm in Southern market.*

Proof: $Q_{SS}^0 < 0 \; iff \; (a + R) < (c + R^2)$

**Proposition 2.2:-**

i. *Without technology transfer innovation will reduce Southern welfare by $\llbracket (R \rrbracket ^2-R)/2$*

ii. *Northern welfare will increase with innovation (even without technology transfer).*

2) ***Imitation***: Imitation by the southern firm is possible only because of the patent regime in the South. Suppose the imitation is possible by southern firm at zero cost due to reluctant patent law in South.

$$\pi_N^i = P_s^i * Q_{NS}^i + P_N^i * Q_{NN}^i - (c - R^2 + R) \; (Q_{NS}^i + Q_{NN}^i) \quad (11)^1$$

$$\pi_S^i = P_s^i * Q_{SS}^i - (c - R^2) Q_{SS}^i \quad (12)$$

The equilibrium outputs and Profits are respectively,

$$Q_{NS}^i = \frac{(a - c + R^2 - 2R)}{3b} \quad (13)$$

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$$Q_{NN}^i = \frac{(a - c + R^2 - R)}{2b} \quad (14)$$

$$Q_{SS}^i = \frac{(a - c + R^2 + R)}{3b} \quad (15)$$

$$\pi_N^i = \frac{(a - c + R^2 - 2R)^2}{9b} + \frac{(a - c + R^2 - R)^2}{4b} \quad (16)$$

$$\pi_S^i = \frac{(a - c + R^2 + R)^2}{9b} \quad (17)$$

**Proposition 2.3:-**

*Under imitation at zero cost, the output and profit of southern firm depends positively on the cost of innovation incurred by North.*

Proof: - Follows from equation (13) and (15)

**Proposition 2.4:-**

*Under no patent protection from south, the Northern firm may stop export if cost of innovation is too low.*

Proof:- $Q_{NS}^i > Q_{NS} \; iff \; R > 2$

Due to the nature of R&D function, export (without patent protection) will be profitable for Northern firm only when cost (resulting in benefit) of imitation is large enough to outweigh the fall in profit due to imitation.

**Proposition 2.5:-**

i. *Southern as well as Northern welfare will increase with innovation and imitation if size of innovation is sufficiently high.*

ii. *As compared to "no technology transfer" state Northern firm will be wore off as its profit from Northern market will decrease.*

3) ***Patent Protection:*** If the southern Patent protection is strong and the Southern government offers full protection, then the southern firm has to pay the loyalty on new technology (R per unit of

production). The Profit functions of the north and South will be:

$$\pi_N^l = P_s^l \; * \; Q_{NS}^l + P_N^l \; * \; Q_{NN}^l - (c - R^2 + R)(Q_{NS}^l + Q_{NN}^l) \qquad (18)^2$$

$$\pi_S^l = P_s^l \; * \; Q_{SS}^l - (c - R^2 + R)Q_{SS}^l \qquad (19)$$

The equilibrium outputs and Profits are respectively:

$$Q_{NS}^l = \frac{(a - c + R^2 - R)}{3b} \qquad (20)$$

$$Q_{SS}^l = \frac{(a - c + R^2 - L)}{3b} \qquad (21)$$

$$\pi_N^l = \frac{(a - c + R^2 - R)^2}{9b} + \frac{(a - c + R^2 - R)^2}{4b} \qquad (22)$$

$$\pi_S^l = \frac{(a - c + R^2 - R)^2}{9b} \qquad (23)$$

### Proposition 2.5:-

*The patent protection offered by south increases the output as well as profit (without considering the revenue from loyalty) of the Northern firm.*

Proof:-
$$Q_{NS}^l > Q_{NS}^i \qquad (24)$$

### C. Optimum Strategy

In period 1, Northern Firm innovates and in period 2 Northern and Southern firm simultaneously decide their strategy. Strategy available to Northern firm is (Export, not Export) and Southern firm is (Imitation, Loyalty payment).

**TABLE I**
**SOUTHERN FIRM**

| | | Southern Firm | |
|---|---|---|---|
| | | Imitation | Loyalty Payment |
| Northern Firm | Export | $\frac{(a-c+R^2-2R)^2}{9b}$ + $\frac{(a-c+R^2-R)^2}{4b}$, $\frac{(a-c+R^2+R)^2}{9b}$ | $\frac{(a-c+R^2-R)^2}{9b}$ + $\frac{(a-c+R^2-R)^2}{4b}$, $\frac{(a-c+R^2-R)^2}{9b}$ |
| | No Export | $\frac{(a-c+R^2-R)^2}{4b}$, $\frac{(a-c)^2}{4b}$ | $\frac{(a-c+R^2-R)^2}{4b}$, $\frac{(a-c)^2}{4b}$ |

### Proposition 2.6:

*For, R>2; (Export, Imitation) is the Nash equilibrium.*

Proof:-

Given, R>2, Export is the dominating strategy. If the Northern firm exports, the southern firm follows imitation.

### Proposition 2.7:-

*For 1<R<2(Export, Loyalty payment) ;( No export, no technology transfer) are two Nash equilibrium.*

Proof:-

Given, R<2, the Northern firm can export iff the South offers protection. South can offer protection if profit of southern firm is higher under protection compares to autarky.

### III.CONCLUSION

To sum up, this paper is a contribution to the ongoing debate on patent protection in the context of technology transfer from the North to South. This paper shows when there is (cost –reducing) innovation in north, Southern firm has no other option but to adopt technology transfer (either by imitation or loyalty payment), otherwise its output will fall and may reach to zero. Export is the dominating strategy for Northern firm once the size of R&D is above some critical level and "imitation" is the best response of southern firm. But if the size of innovation is below some critical level, then the optimum policy of Northern firm will depend upon the patent protection regime in South.

The entire analysis has been carried out mostly from the view point of northern and southern firm. One possible extension of the paper can be product differentiation. The Northern firm may export the product produced by pre-innovation (so outdated) technology depending on the patent regime in the Southern market.

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2 "l" stands for loyalty payment.

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