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# INNOVATIONS AND INTERNATIONAL TRADE

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*Abstract*: Innovations are rightly recognized as the engines of economic growth, but the distinction between process (cost-reducing) innovation and product (quality-improving) innovation is not thoroughly explored especially in the theory of international trade. This paper compares positive and normative implications of process and product innovations in a simple two-country model of international trade. The effects of cost-reducing and quality-improving innovations on the terms of trade and economic welfare are revealed almost diametrically opposite. A cost-reducing innovation in a country's export industry may give rise to a self-damaging "immiserising growth," whereas a quality-improving innovation in the same industry may lead to a beggar-my-neighbor "inverse immiserising growth." We will elucidate and interpret the exact conditions for these paradoxes to materialize.

**Key words:** product (quality-improving) innovation, process (cost-reducing) innovation, immiserising growth, inverse immiserising growth, Prebisch-Singer thesis, international competitiveness.

**JEL Classification Number:** F10, F11, O12, O31, O41.

## 1. INTRODUCTION

Innovation plays a key role in the theory of economic growth, but it contains different elements. Roughly, they can be divided into two distinct categories, i.e., process innovations and product innovations. The former may also be named "cost-reducing innovations" in the sense that they take place through the discovery of new processes to produce the old products at lower costs. In contrast, the latter may be called "quality-improving innovations" since they occur through the creation of new products with higher qualities. Both categories of innovations are of course important as the engines of economic development, but their implications for economic welfare can be vastly different from time to time and from place to place. In poor economies in the early stage of

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development, process innovations in the daily necessities contribute significantly to the life of people. In affluent societies in the modern age, however, "it would be a terribly dull life if innovations only reduced costs of producing the same menu of goods and services that now populate their markets.[1]" Product innovations are crucially important in such a situation. This paper compares the welfare implications of cost-reducing and quality-improving innovations in the context of modern international economies in which both poor and affluent countries coexist and interact.

Standard textbooks on trade theory teach that a growth in a country's export industry could be a curse rather than a blessing for its economic welfare. They argue that it brings about a deterioration of its terms of trade thereby necessarily benefitting its trading partner but possibly damaging its own welfare when the direct gain from the innovation is relatively small[2]. This proposition is, however, based on the implicit assumption that the growth occurs through a cost-reducing innovation and is definitely untenable if it is the outcome of a quality improving innovation. In fact, a quality-improving innovation in any product will generally increase its demand and lead to a rise in its relative price. The traditional literature on trade and growth has apparently overlooked this point because of its unwarranted preoccupation with cost-reducing innovations.

In the real world, there are many important quality-improving innovations as well as cost-reducing innovations. For instance, the high growth of the Japanese economy on 1960s and 70s may be explained by a series of both types of innovations achieved in important modern manufacturing industries such as steel, automobiles, electric machinery, precision and machine tool instruments, etc. originally imported from the West. The stagnation of the Japanese economy since 80s may be attributable to the decrease of quality-improving innovation after the completion of catching-up process to the West. In the 21$^{th}$ century, however, we will perhaps witness a new surge of product innovations related to the conservation of energy and environment such as solar generators and electric vehicles.

In Section 2, we develop a simple general equilibrium model of innovations and international trade between the"home" and "foreign" countries. In Section 3, we begin by exploring the effects of a cost-reducing innovation in the home country's export industry and recapitulate the possibility of widely publicized "immiserising growth". The necessary and sufficient condition for immiserising growth in the present model is that the price elasticity of the world demand for the product is smaller than its export ratio (the share of export in the domestic output). In section 4, we consider the effects of a quality-improving innovation in the home export industry. In sharp contrast to cost-reducing innovations, this type of innovation gives rise to an improvement of the home country's terms of trade and may impoverish its trading partner ("*inverse* immiserising growth", say). Section 5 presents a necessary and sufficient condition for inverse immiserising growth in a solvable example of the model. Loosely speaking, we may

[1] Oi (1997), p. 134,

[2] The possibility of self-damaging innovations was aptly named "immiserising growth" and made popular by Bhagwati (1957a, b).

say that inverse immiserising growth occurs when the quality improvement achieved by the innovation is not as highly regarded in the foreign country as in the home country. Finally, Section 6 discusses the significance and limitations of the model.

## 2. PRODUCT QUALITY AND INTERNATIONAL TRADE: THE MODEL

Let us consider a simplest two-country, two-good model of international trade. There are two countries, home and foreign. The home country specializes completely in the production of good $x$ and the foreign country in the production of good $y$. Perfect competition prevails in the home and foreign markets and all factors are fully employed in both countries. Factors of production are not allowed to move internationally, implying that the supply of each good is fixed, given the product quality and production technology. On the other hand, goods are freely traded internationally, ensuring the international equalization of good prices.

The representative consumers in each country are assumed to possess a Marshallian, quasi-linear utility function with product $y$ serving as "money". The utility function of the home consumers is written,

$$u = Y + v(X, q)\,, \quad v_1 > 0\,, \quad v_2 > 0\,, \quad v_{11} < 0\,, \quad v_{22} < 0\,, \quad v_{12} > 0 \tag{1}$$

where $X$ and $Y$ denote the consumption of good $x$ and $y$ respectively, $q$ indicates the quality of good $x$, $v_1$ and $v_2$ signify the partial derivative of function $v(X, q)$ with respect to $X$ and $q$ respectively. Similarly, $v_{11}$ and $v_{12}$ denote the partial derivatives of $v(X, q)$ respectively. (In what follows, we shall use similar notation when necessary). The marginal utilities of the home product $x$ and that of its quality are positively decreasing, whereas the marginal utility of the foreign product or "money" is assumed to be constant. The foreign consumers also possess a similar utility function,

$$u^* = Y^* + v^*(X^*, q^*)\,, \quad v_1^* > 0\,, \quad v_2^* > 0\,, \quad v_{11}^* < 0\,, \quad v_{22}^* < 0\,, \quad v_{12}^* > 0 \tag{2}$$

We follow the convention in trade literature (originated by Murray Kemp) to attach asterisks to the foreign variables in distinction from the home variables.

For simplicity, we assume that the home country produces good $x$ only at the highest quality level under given technology. By assumption, the home and foreign consumers must satisfy the budget constraint,

$$Y + pX = p\bar{X} \tag{3}$$

$$Y^* + pX^* = \bar{Y}^* \tag{4}$$

where $\bar{X}$ and $\bar{Y}^*$ denote the full-employment outputs of the home and foreign products respectively, assumed to be fixed as of given factor endowments and technologies. The home and foreign consumers face the same international price, $p$ under free trade without any trade impediments.

The utility maximization of the home and foreign consumers subject to budget constraints (3) and (4) leads to

$$v_1(X, q) = p\,, \tag{5}$$

$$v_1^*(X^*, q) = p\,. \tag{6}$$

Solving (5) and (6) for $X$ and $X^*$, we obtain the home and foreign demand functions for product $x$:

$$X = x(p, q)\,, \tag{7}$$

$$X^* = x^*(p, q)\,. \tag{8}$$

Note that these are functions of only of $p$ and $q$. Thus the equilibrium condition for international product market may be written,

$$x(p, q) + x^*(p, q) = \bar{X}\,. \tag{9}$$

Given the quality of product $x$, equation (9) determines the free trade equilibrium price $p$ as a function of $q$ and $\bar{X}$.

In this equilibrium, the utility of each country depends upon its terms of trade (or the relative price of product $x$), the quality of product $x$, and the total supply of each product. Totally differentiating (1), (2), (3) and (4) and rearranging terms in light of (5) and (6), we obtain

$$du = -(Y - X)dp + v_2 dq + p d\bar{X}\,, \tag{10}$$

$$du^* = -X^* dp + v_2^* dq + d\bar{Y}^*\,. \tag{11}$$

A rise in the relative price of product $x$ increases the utility of its exporter, or the home country, but decreases the utility of its importer, or the foreign country. An improvement in the quality of product generally increases the utility of both countries. Other things being equal, an increase in the total supply of the home product $x$ increases the home country's utility and an increase in the total supply of the foreign product increases the foreign country's utility. Equations (10) and (11) play important roles in the welfare analysis below.

## 3. THE EFFECTS OF A PROCESS INNOVATION

To start with, let us consider process innovations as a bench mark. Suppose that an innovation occurred in the production process of the home country, reducing the cost of product $x$, but keeping its quality unchanged. In the present model, it simply gives rise to an increase in the total supply of product $x$. Differentiating equation (9) with respect to $\bar{X}$, we get

$$\frac{dp}{d\bar{X}} = \frac{1}{x_1 + x_1^*}\,. \tag{12}$$

From (5) and (6) we have

$$x_1 = \frac{1}{v_{11}}\,, \tag{13}$$

$$x_1^* = \frac{1}{v_{11}^*}\,. \tag{14}$$

The substitution of (13) and (14) into (12) yields

$$\frac{dp}{d\bar{X}} = \frac{\nu_{11}\nu_{11}^*}{\nu_{11} + \nu_{11}^*} < 0\,. \tag{15}$$

Naturally, the increase in the supply of product $x$ due to the cost-reducing innovation in the home export industry brings about a decline of its relative price thereby increasing its consumption in both countries and benefitting the importing foreign country. The question is whether this type of innovation is also beneficial to the home country. The increase in the supply of $x$ would in itself benefits the home consumers but the concurrent terms of trade deterioration would subtract from, or even overturn the beneficial output effect. Generally, we cannot rule out the possibility of a well known "immiserising growth"[3]. Setting $dq = 0$ in (10) and (11), we get

$$\frac{du}{d\bar{X}} = p + (\bar{X} - X)\frac{dp}{d\bar{X}}\,, \tag{16}$$

$$\frac{du^*}{d\bar{X}} = -x^*\frac{dp}{d\bar{X}} > 0 \tag{17}$$

Equation (17), together with (15), shows that the foreign country unambiguously benefits from the innovation through its favorable effects on the terms of trade. Using (12), we can further rewrite (16) as

$$\frac{du}{d\bar{X}} = p\left(1 - \frac{\bar{X} - X}{X + X^*} \cdot \frac{1}{\eta}\right)\,, \tag{18}$$

where $\eta$ is the price elasticity of the world demand for $x$ defined by

$$\eta = -\frac{p}{X + X^*} \cdot (x_1 + x_1^*) > 0\,. \tag{19}$$

PROPOSITION 1 (Immiserizing growth). *The necessary and sufficient condition for the immiserizing growth consequent upon a process innovation in the home export industry is*

$$\eta < \frac{\bar{X} - X}{X + X^*} = \frac{\bar{X} - X}{\bar{X}}\,. \tag{20}$$

*This means that the price elasticity of the world demand for $x$ is smaller than the home country's export ratio, or export share in the total domestic supply of $x$.*

It is likely to be satisfied in the case of a typical underdeveloped export economy specialized in a primary product for which the world demand is price inelastic.

Figure 1 illustrates the effects of a cost-reducing innovation in the production of $x$. The world demand curve for $x$ is given by $D_W$ and the home demand curve by $D_H$. (For simplicity, we assume that both home and world markets exhibit the same prohibitive price). Suppose that the initial supply of $x$ is shown by $OA$, and the corresponding initial equilibrium price by $OB$. The initial home consumption of $x$ is conformably shown by $BC$ and the export by $CE$. The initial home consumer's surplus is measured by the triangle $BCD$ and the initial producer's surplus by rectangle $OBEA$, whereas the initial foreign consumer's surplus is triangle $DCE$. Starting from this initial situation,

[3] Bhagwati (1958a, b).

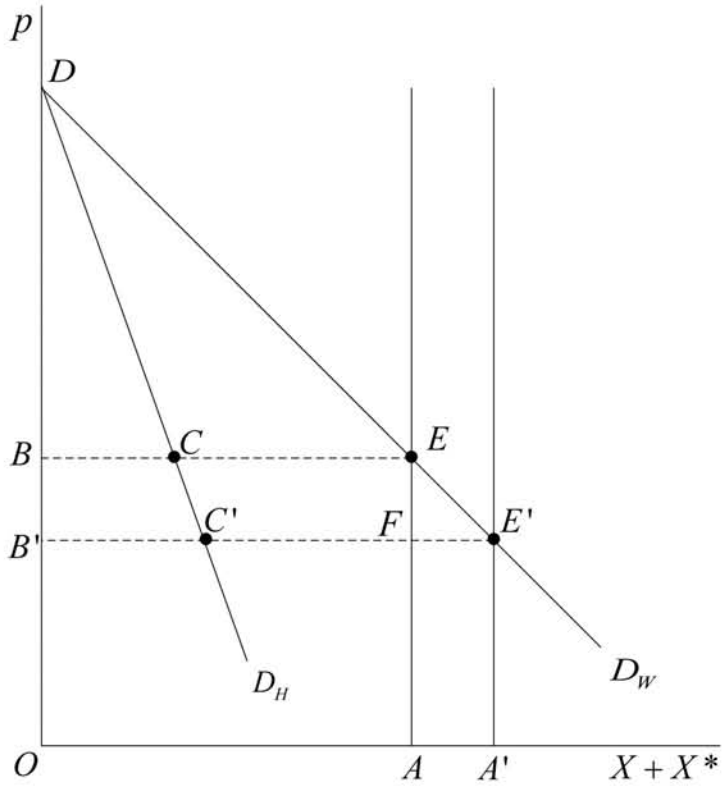


Figure 1. The Effects of a Process Innovation.

suppose that a cost-reducing innovation increases the home supply of $x$ toward $OA'$ and lowers the equilibrium price to $OB'$. In the subsequent new equilibrium, the foreign consumer's surplus increases to $DC'E'$ and the home consumer's surplus also increases to $DB'C'$. The home producer's surplus changes to $OB'E'A'$. Thus the sum of home consumer's and producer's surplus increases or decreases, depending upon whether $CC'FE'$ is smaller or larger than $FAA'E$. The condition that $CC'FE$ is larger than $FAA'E$ coincides with the condition for immiserizing growth, i.e., (19) when the increase in the supply of $x$ is infinitesimally small. Clearly, the world social surplus, or the sum of the world consumer's surplus and producer's surplus increases from $ODEA$ to $ODE'A'$.

## 4. THE EFFECTS OF A PRODUCT INNOVATION: GENERAL CASE

The possibility of immiserising growth that a cost-reducing innovation in the home country's export industry may decrease its welfare is well known and well documented in the trade literature. Surprisingly, much less attention has been paid to the almost diametrically opposite welfare effects of quality-improving innovations. In this section, we

employ the present simple model of international trade to show that a *quality-improving* innovation in the home country's export industry necessarily increases its welfare and may lead to the immiserisation of the foreign country. Keeping $\bar{X}$ at a given level, differentiate equation (9) with respect to $q$ to obtain

$$\frac{dp}{dq} = -\frac{x_2 + x_2^*}{x_1 + x_1^*}, \tag{21}$$

where

$$x_2 = -\frac{v_{12}}{v_{11}} \tag{22}$$

$$x_2^* = -\frac{v_{12}^*}{v_{11}^*} \tag{23}$$

in view of (5) and (6). From (13), (14), (22) and (23), we can rewrite (21) as

$$\frac{dp}{dq} = \frac{v_{11}v_{12}^* + v_{11}^* v_{12}}{v_{11} + v_{11}^*} > 0. \tag{24}$$

Note that the quality-improving innovation increases the demand for $x$, thereby raising its relative price. In particular, consider the special case in which the innovation increases the marginal utility of the product equally both at home and abroad, or $v_{12} = v_{12}^*$. Equation (24) then simplifies to

$$\frac{dp}{dq} = v_{12} = v_{12}^*. \tag{25}$$

In this case, the size of price increase equals the increase in the marginal utility of the product both at home abroad. How about the consequent change in the foreign import as compared to its home consumption of $x$? It depends upon the comparative effects of the increase in the marginal utility of the product as perceived by the home and foreign consumers. Differentiating (5) and (6) with respect to q, and making use of (24), we obtain

$$\frac{dX^*}{dq} = -\frac{v_{12}^*}{v_{11}^*}\left(1 - \frac{v_{11} + v_{11}^* v_{12}/v_{12}^*}{v_{11} + v_{11}^*}\right). \tag{26}$$

The foreign import of product $x$ increases if and only if $v_{12}^* > v_{12}$. Since the total supply of product $x$ is unaffected by the innovation, the home consumption of $x$ decreases under the same condition.

The effect of technological improvement of this type on the home consumer's utility is definitely positive since it improves both the quality of the product and its relative price. In fact, setting $d\bar{X} = 0$ in equation (10), we have

$$\frac{du}{dq} = (\bar{X} - X)\frac{dp}{dq} + v_2 > 0. \tag{27}$$

The first term on the right hand side (the terms of trade effect) and the second term (the quality effect) are both positive. In contrast, its effect on the foreign consumer's utility becomes ambiguous. The quality improvement effect benefits the foreign consumers, but its terms of trade effect affects them perversely. Note, from (11),

$$\frac{du^*}{dq} = -X^* \frac{dp}{dq} + v_2^* \tag{28}$$

where the first term on the right hand side is negative, but the second term is non-negative. The net effect is indeterminate, depending on the relative size of the opposing effects

The phenomenon that the quality-improving innovation originated in the home export industry imposes a net welfare loss on the foreign country is hardly discussed in the trade literature. Here, let us focus on the possibility of such a phenomenon, naming it "inverse immiserisng growth." In practice, its relevance is widely recognized in the popular writings on the "competitiveness" of different countries[4]. Theoretically, suppose that a quality-improving innovation in a country's export good is highly regarded at home but deemed unimportant among foreigners, or $v_2 > 0$ and $v_2^* = 0$. In view of (24) and (28), this is clearly a typical case of inverse immiserising growth.

To be more precise, substitute (24) into (28) to get

$$\frac{du^*}{dq} = v_2^* \left( 1 - \frac{\varepsilon^* (v_{11}^* v_{21} / v_{21}^* + v_{11})}{v_{11} + v_{11}^*} \right), \tag{29}$$

where $\varepsilon^*$ denotes the consumption elasticity of foreign utility increase from the quality improvement of $x$, i.e.,

$$\varepsilon^* = \frac{v_{21}^* X^*}{v_2^*} > 0 . \tag{30}$$

From this, the necessary and sufficient condition for inverse immiserising growth is:

$$\varepsilon^* > \frac{v_{11} + v_{11}^*}{v_{11}^* v_{21} / v_{21}^* + v_{11}} . \tag{31}$$

Given the magnitude of $\varepsilon^*$, this condition is likely to be satisfied when the marginal utility increase from the quality improvement of $x$ perceived by the foreign consumers (indicated by $v_{21}^*$) is small compared to that perceived by the home consumers (indicated by $v_{21}$). It simplifies to $\varepsilon^* > 1$ in the case where it affects both consumers equally, or $v_{21} = v_{21}^*$. Note also that if $\varepsilon^* = 1$, the innovation is neutral to the foreign consumer's well-being in the sense that it leaves the foreign consumer's utility totally unaffected. Suppose that $v_{21} = v_{21}^*$. The condition $\varepsilon^* > 1$ can then be written,

$$\frac{v_2^*}{X^*} < v_{21}^* . \tag{32}$$

It means that the average utility increase from the quality improvement falls short of the marginal utility increase from the quality improvement. As pointed out above, the relative price increase of product $x$ due to the quality improvement imposes a utility loss on the foreign consumers, which is exactly matched by the marginal utility increase from the quality improvement in this special case (See (25)). Thus condition (32) clearly shows that the foreign consumer's utility declines as a result of the quality improvement. To sum up, we can put forward

[4] For a sharp critique on the concept of international competitiveness, See Krugman (1994)

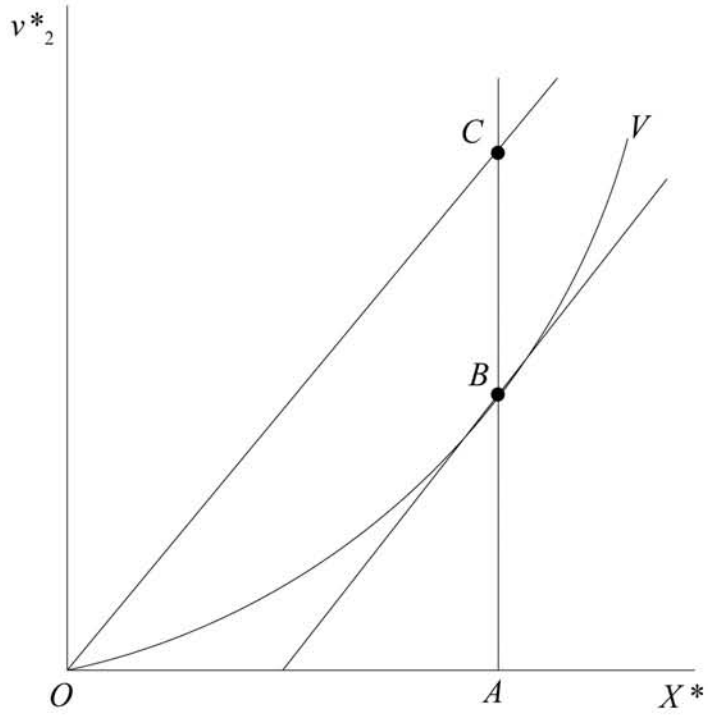


Figure 2. Foreign Utility Change from a Product Innovation.

PROPOSITION 2 (inverse immiserization). *A quality–improving innovation in the home export industry immiserises the foreign country if and only if*

$$\varepsilon^* > \frac{v_{11} + v_{11}^*}{v_{11}^* v_{21}/v_{21}^* + v_{11}} \tag{33}$$

*Specifically, inverse immiserization occurs if* $v_{21} > v_{21}^*$ *and* $\varepsilon^* = 1$, *or if* $v_{21} = v_{21}^*$ *and* $\varepsilon^* > 1$[5].

Figure 2 illustrates the condition that $\varepsilon^* > 1$ when $v_{21} = v_{12}^*$. The Curve $OV$ depicts $v_2^*$, the increase of the foreigner's marginal utility due to the quality improvement as a function of $X^*$. Assuming $v_2^*(0, q) = 0$, it goes through the origin and upward rising[6]. $\varepsilon^* > 1$ implies that the curve is strictly convex below. Suppose that the initial

[5] Examples of utility function that satisfies $\varepsilon^* = 1$ or $\varepsilon^* > 1$ will be given and discussed in the next section.

[6] $v_2^*(0, q) = 0$ means that the quality improvement of $x$ does not affect utility, when there no consumption of $x$. Note that $\varepsilon^* > 1$ if and only if $v_{211}^* > 0$, which is often employed in the policy analysis of product quality. For instance, see Spence (1976) and Krishna (1987).

consumption of $x$ is given at $OA$. The increase in the foreign consumer's utility due to the quality-improving innovation of the product is shown by the area $OAB$, or the integration of $v_2^*$ along segment $OA$. In the present special case where $v_{12} = v_{12}^*$, the increase in the price of $x$ equals $v_{12}^*$, or the slope of $OV$ at point $B$. The loss of the foreign consumer's utility due to this price hike is given by the triangle $OAC$ that is greater than the area the below the curve $OV$ along segment $OA$. Thus the total increase in the foreigner's utility is negative. On the other hand, the foreigners will become better-off in the special case in which $\varepsilon^* < 1$ and $v_{12}^* = v_{12}$.

In passing, it should be noted that the rise in the price of product $x$ consequent upon its quality improvement does not necessarily mean the deterioration of the foreign country's terms of trade. In fact, the gain from the quality improvement may outweigh the loss from the price rise, making the foreigners better-off in the ultimate analysis. In general, the price of a country's export good in terms of its import good is not a good indicator of the terms of trade in the true sense of the word when the quality-improving innovation is taking place. Let $\pi^*$ denote the foreign terms of trade in distinction from the relative price $p$ of product $x$. The differential change of $\pi^*$ with respect to $q$ may be defined by

$$\frac{d\pi^*}{dq} = -\frac{dp}{dq} + \frac{v_2^*}{X^*}. \tag{34}$$

The first term on the right-hand side may be taken as the relative price effect and the second term as the direct effect of a quality improvement of product $x$ on the terms of trade. Note that the foreign country enjoys gains amounting to $v_2^*/X^*$ per unit of its import from the quality improvement of product $x$ even in the absence of relative price change. In view of equation (11), the foreign country's utility depends on the terms of trade improvements as defined above, as well as on the supply of its national product.

Similarly, let $\pi$ denote the home country's terms of trade. Its differential change with respect to $q$ may be written,

$$\frac{d\pi}{dq} = \frac{dp}{dq} - \frac{v_2}{X^*}. \tag{35}$$

The home country's terms of trade may be said to deteriorate if there is a quality improvement of $x$ at the unchanged relative price of product $x$.

## 5. PRODUCT INNOVATION: AN EXAMPLE

The foregoing analysis of product innovation introduced a condition for "inverse-immiserising growth." It contains a somewhat unfamiliar concept of the consumption elasticity of utility increase from quality improvement, denoted by $\varepsilon$. In order to exemplify this concept, let us consider here some specific cases of relevant utility functions such as

$$v(X, q) = -\frac{aX^2}{2} + qbX, \tag{36}$$

$$v^*(X^*, q) = -\frac{aX^{*2}}{2} + \alpha qbX^*, \quad a, b > 0, \quad \alpha \geq 0. \tag{37}$$

The corresponding demand functions are linear:

$$p = -aX + qb\,, \tag{38}$$

$$p = -aX^* + \alpha qb\,. \tag{39}$$

Note that the implied demand curves have the same slope and different intercepts. We can easily show that $\varepsilon^* = 1$ in the example. A quality-improving innovation in product $x$ shifts up these functions upward and in a parallel fashion. Parameter $\alpha$ indicates differential evaluation of a given quality improvement between the home and foreign consumers. For instance, $\alpha < 1$ means that the foreign consumers do not marginally evaluate the innovation as highly as the home consumers. In this case, equation (25) above simplifies to

$$\frac{dp}{dq} = \frac{(1+\alpha)b}{2}\,. \tag{40}$$

A quality-improving innovation of product $x$ leads to a rise in the price of $x$ and an increase in the home consumer's utility. We can also specify (27) as

$$\frac{du^*}{dq} = \alpha bX^*\left(1 - \frac{1+\alpha}{2\alpha}\right)\,. \tag{41}$$

The consumption elasticity of foreign utility increase from quality improvement is unity, or $\varepsilon^* = 1$ and the condition for inverse immiserising growth becomes $\alpha < 1$. An improvement in the quality of the home product decreases the foreign utility when the induced shift of the foreign demand curve is smaller than that of the home demand curve. Here, equation (32) can be written,

$$\frac{d\pi^*}{dq} = \frac{(\alpha-1)b}{2}\,. \tag{42}$$

Adjusted for the quality improvement, the foreign country's terms of trade deteriorates, if $\alpha < 1$.

Figure 3 illustrates the effect of a product innovation on the foreign utility when $\alpha = 1$, so that demand functions are identical. $D_H$ and $D_W$ show the single-country and world demand curves for product $x$ respectively. The total supply of $x$ is given at the level of $OA$. At the initial equilibrium, each country consumes $BC(= CE)$ of $x$ at the price of OB. The social surplus of the home country's is the sum of areas $OAEB$ (producer's surplus) and DBC (consumer's surplus), and that of the foreign country is equal to the area $DCE$ (consumer's surplus). By virtue of the subsequent quality improvement of $x$, the demand curves shift upward toward $D'_H$ and $D'_W$ by the amount of $BB' = EE'$. At the new equilibrium, the price rises to $OB'$, and both countries consumes the same amount $B'C' = BC$ of $x$ as before. In this special case, the effects of quality improvement and price hike on the quantity consumed cancel each other completely. As a result, the home country's social surplus increases by the area $BEE'B$, but the foreign country's surplus remains unchanged at $D'C'E' = DCE$. Needless to say, this is the borderline case. The foreign country's surplus increases when $\alpha > 1$, and decreases when $\alpha < 1$.

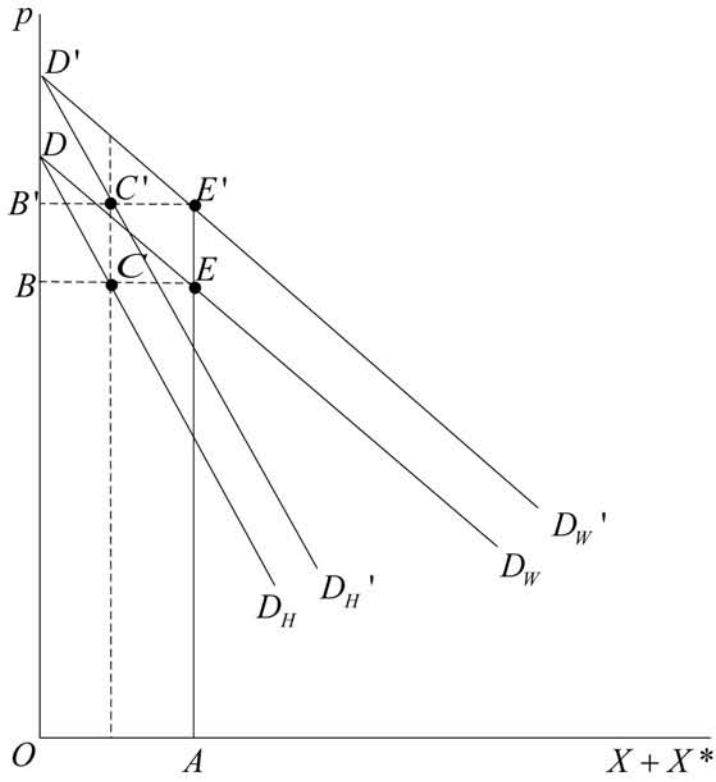


Figure 3. The Effects of a Product Innovation: An Example.

As pointed above, $\varepsilon^* = 1$ in the present example. Consider another example of utility functions:

$$v(X, q) = -\frac{a}{q}X^{\beta} + bX\,, \quad \beta > 0\,, \tag{43}$$

$$v^*(X^*, q) = -\frac{a}{aq}X^{*\beta} + bX^*\,, \quad \alpha > 0\,, \tag{44}$$

Where $\varepsilon^* = \beta$. To save space, we omit the detailed analysis of this example.

## 6. CONCLUDING REMARKS

The foregoing analysis shows that a product innovation in the home export industry increases the utility of the foreign country only if it is at least well received in the foreign country as in the home country. We may roughly conclude that a quality-improving innovation in the home export industry benefits the home consumer presumably at the expense of the foreign consumer in sharp contrast to the standard text-book teaching

that a cost-reducing innovation in the same industry are generally beneficial to the foreigners. Thus we should carefully take account of the differential effects of product and process innovations in evaluating the controversies over international distribution of gains from trade.

First, let us consider the vertical trade between industrialized and agricultural countries. In advanced industrialized countries with large domestic markets, product innovations are likely to introduce quality improvements that cater to the home consumer's preference rather than to the foreign consumer's taste. Thus their product innovations tend to benefit themselves more than agricultural countries irrespective of the adverse terms of trade effects. In contrast, agricultural countries with small domestic markets tend to introduce quality improvements suitable for the large foreign markets and benefit the industrialized countries more than themselves through the resulting terms of trade deterioration. This analysis helps us to reconsider the time-honored "Prebisch-Singer Thesis" to the effect that the long-term rise in the price of manufactures relative to agricultural product has diminished the trade gains of developing agricultural countries vis-à-vis developed industrialized countries[7]. The foregoing analysis indeed suggests that the quality-improving innovations in industrialized countries may be responsible for the adverse terms of trade movements (in the usual sense of the word) against agricultural countries. As argued above, however, the terms of trade deterioration does not necessarily mean loss of trade gains for agricultural countries since the beneficial effects of the quality-improving innovations may more than compensate the adverse terms of trade effects. For instance, Lipsey (1994) shows that there have been no long term trend toward rising-prices of manufactures relative to primary product prices during the 1980s when the price indices of manufactures are adjusted for quality change and other influences.

Quality-improving innovations in manufactures are also important in the horizontal trade between industrialized countries. Krugman (1994, 1995) criticized what he called "pop internationalism," that popularized the concept of national "competitiveness" as a keyword for understanding international economic relations on 1990s. He argued that the definition of national competitiveness is much more problematic than corporate competitiveness. If a corporation fails to compete with rivals, it must go out of business, but countries do not go out of business even if they are unhappy with their economic performance. For example, suppose that a cost-reducing innovation occurs in the home country's export industry in the absence of any innovation in foreign country. Does it mean that the home country gets prosperous at the sacrifice of foreign country? On the contrary! The foreign countries will benefit from the innovation in the home country through its terms of trade effect. Moreover, the home country may get worse-off from its own innovation. Thus, in the case of international competition in cost-reducing innovation, the winner may not gain after all, while the loser is bound to gain. In contrast, suppose that a quality-improving innovation occurs in the home country's export industry in the absence of any innovation elsewhere. As shown in this paper, it will definitely

[7] See Prebisch (1949) and Singer (1950).

benefit the home country's welfare but may hurt foreign countries through its effects on the terms of trade. The abuse of the word "competitiveness" is certainly confusing, but it should be meaningful to talk about competitiveness in quality-improving innovative capacity.[8]

Finally, a few words for the limitations of the present model may be in order. First, it is a general equilibrium model under the special assumption that the representative consumers exist with Marshallian quasi-linear utility functions. This assumption implies that the demand for the product in question depends only on its relative price independent of the consumer's income. It is misleadingly named the "partial equilibrium" model more often than not. This assumption does not essentially affect the conclusion that a quality-improving innovation in the home country's export industry raises its relative price and increases its welfare, while it may decrease the trading partner's welfare. Second, it is assumed that the home country specialize completely in the production of product $x$ (ordinary good) and the foreign country in the production of $y$ (Marshallian "money"). This assumption is also essentially innocuous in deriving the message of the present analysis that quality-improving innovations and cost-reducing innovations in the home export industry exerts asymmetric effects on the terms of trade and the well being of the home and foreign consumers. Relaxing this assumption and stepping into the world where the home and foreign countries specialize incompletely in the production of the two goods, we would have to take into account the differentiation of home and foreign non-money products and consider the quality-improving innovations in each of them. The essential message of the original model that a quality-improving innovation in any industry will lead a rise in its relative price would remain intact. We would be able to infer its welfare implications roughly on the basis of this message as in the preceding analysis.

## REFERENCES

Bhagwati, J. (1958a). "Immiserizing Growth: A Geometrical Note," *Review of Economic Studies*, 25, 201–205.

Bhagwati, J. (1958b). "International Trade and Economic Expansion," *American Economic Review*, 48, 941–953.

Krishna, Kala (1987). "Tariffs versus Quota with Endogenous Quality," *Journal of International Economics*, 23, 97–122.

Krugman, Paul (1994). "Competitiveness; A Dangerous Obsession, *Foreign Affairs*, March/April, 28–44.

Krugman, Paul (1996). *Pop Internationalism*, The MIT Press,

Lipsey, Robert E.(1994). "Quality Change and Other Influences on Measures of Export prices of Manufactured Goods and the Terms of Trade between Primary Products and Manufactures," *NBER Working Paper* 4671.

Oi, Walter Y. "The Welfare Implications of Invention," in *The Economics of New Goods*, Timothy F. Bresnahan and Robert J. Gordon (eds.), NBER, Univ. of Chicago Press, 1997.

Prebisch, Raul (1949). *The Economic Development of Latin America and its Principal Problems*, United Nations.

[8] Krugman (1994, 1996) considered-only cost-reducing competition but apparently overlooked quality-improving competition.

Singer, Hans W. (1950). "The Distribution of Gains between Investing and Borrowing Countries," *American Economic Review*, 40, 473–485.

Spence, A. Michael (1976). "Monopoly, Quality and Regulation," *Bell Journal of Economics*, 6, 417–429.