Increasing Returns, Product Quality and International Trade

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This paper examines the roles of quality and increasing returns in trade. It implies that there is intense intra-industry trade among economies with similar levels of per capita income, which increases both the quality and the quantity of consumption. However, there may be no trade in manufactured goods between rich and poor countries because of the disparity in their optimal qualities of consumption and the high complementarity of the qualities of intermediate goods in production. Thus, it helps explain the observed trade patterns. Moreover, the model shows that a smaller country is more likely to engage in international trade.

INTRODUCTION

Since the Second World War, the largest volume of world trade has been among the developed countries themselves, rather than between the developed and the developing countries (see e.g. the survey by Deardorff 1984 and Ethier 1995). This important stylized fact indicates that the Heckscher–Ohlin model may not be adequate for explaining the patterns of trade. Consequently, it has motivated at least two major advances in the theory of international trade.

First, on the basis of Adam Smith’s (1776) insight, Krugman (1979), Lancaster (1980), Helpman (1981) and Ethier (1982), among others, formalized the idea that scale economies resulting from the increase in the division of labour are a cause of international trade. These models provide a clear explanation for the existence of trade, which is usually in the form of intra-industry trade, among developed countries with similar technologies and factor endowments.

Second, there has been an increasing awareness of the importance of product quality in international trade. For example, Flam and Helpman (1987) develop a model of North–South trade in which quality enters into an individual’s utility function. Assuming that richer countries have comparative advantages in producing higher-quality goods, their model explores the overlap of income distribution between poor and rich countries as the source of trade. Further, extending the Flam–Helpman model, Copeland and Kotwal (1996) and Murphy and Shleifer (1997) investigate the conditions that trade may not exist between rich and poor countries when their incomes differ.

On the basis of insights from the above literature, this paper explores the role of product quality in international trade in a model in which trade is due to economies of scale and individuals may have different demands for quality. In fact, the basic idea of this paper dates back to Linder (1961), who observes that both increasing returns to scale and product quality are important in explaining the patterns of trade in manufactured goods.1
My major assumption is that in industrial specialization the qualities of different intermediate goods are highly complementary in producing the quality of the final good. For example, a computer will not work if just one out of the thousands of its components fails. In making this assumption, I borrow heavily from a pioneering contribution by Kremer (1993), who provides an excellent analysis and survey of much empirical evidence for a similar assumption and utilizes the assumption to analyse the matches of workers with different skills within a firm.

In a nutshell, my argument is as follows. Under the conventional assumption that quality is a normal good, people's demand for quality will increase as their incomes rise. So, on one hand, if the representative individual’s human capital in different countries is similar, individuals in these economies will demand goods of a similar quality. In this case, the model implies that every country will engage in international trade, which will increase the quality as well as the quantity of every individual’s consumption. On the other hand, if a country’s representative individual’s human capital (and hence income) is low relative to that of the rest of (industrial) world, then individuals in that country will generally have a lower demand for quality. In this case, the analysis shows that the economy will choose to engage in international trade only if the conflict of preference is relatively small and the degree of increasing returns to scale is relatively high.

However, under some circumstances the conflict in the preferences for quality may outweigh the benefit of participating in the global industrial specialization. Under some reasonable conditions, the model implies that there exists a threshold level of human capital such that an economy will engage in international trade if and only if its representative individual’s human capital is above this threshold level. In other words, despite the higher efficiency of international specialization in the production of high-quality goods, individuals in a poor country may find themselves better off by choosing autarky to produce and consume a greater quantity of goods with lower quality, than by being part of the global industrial specialization and consuming a lower quantity of higher-quality goods.

Because of the disparity in their optimal qualities of consumption, trade in manufactured goods may not occur between countries with very different levels of per capita human capital and income. Thus, this paper complements the existing literature to explain the observed trade patterns that the largest volume of international trade (in manufactured goods) is between developed countries with similar technologies and factor endowments. Meanwhile, this model helps formalize Linder’s (1961) hypothesis that the similarity of demand and increasing returns to scale are the major sources of international trade in manufactured goods. Moreover, the analysis implies that a smaller country gains more from taking advantage of international increasing returns to scale because of its smaller domestic market size. Therefore, a smaller country is more likely to engage in international trade.

Finally, this paper yields some interesting policy and growth implications. For example, it suggests that developing countries may benefit more from seeking trading opportunities among themselves than from trading with rich countries in their early stages of development. Also, the model sheds light on an empirical regularity emphasized by Lucas (1993) that economies growing
the fastest would often begin to export some new manufactured goods not
exported by them before. Further, the analysis implies that a smaller country is
more likely to experience trade-induced rapid economic growth.

The remainder of the paper is organized as follows. Section I sets up the
basic analytical framework. Section II investigates the production and con-
sumption in a closed economy. Sections III and IV analyse the trade between
countries with the same level of per capita human capital and between
developed and developing countries, respectively. Section V offers a summary
of the paper.

I. THE BASIC ANALYTICAL FRAMEWORK

Preferences

Consider an economy in which there is a single consumption good. Every
individual in the economy obtains utility from the consumption of both the
quality and the quantity of the good, and has the utility function

\[ v(M, Q), \]

where \( M \) and \( Q \) denote the consumption of the quantity and the quality of the
good, respectively. For simplicity, I assume that an individual consumes at the
same quality level.\(^3\) The utility function, \( v(M, Q) \), is strictly increasing with
respect to both of its variables.

Production

I build on Dixit–Stiglitz (1977) model of monopolistic competition with slight
modifications to formalize industrial specialization. Following Ethier (1982)
and many others, I assume that the single (final) consumption good is
produced through the costless combination of a variety of differentiated inter-
mediate goods (or processes). The economy is assumed to be able to produce
any of a large number of intermediate goods with any level of quality. The
technology satisfies the property of constant returns to scale for a given set of
inputs. Specifically, the production function of the quantity is defined as

\[
X = \left( \sum_{i=1}^{n} x_i^\theta \right)^{1/\theta}, \quad 0 < \theta < 1,
\]

where \( X \) denotes the quantity of the final output, \( x_i \) denotes the quantity of the
\( i \)th intermediate product, \( n \) denotes the number of the intermediate products
and \( \theta \) measures the degree of substitution between different intermediate
products.

I assume that the qualities of different intermediate goods are highly
complementary in producing the quality of the final consumption good. The
simplest formulation that can capture this property is that the qualities of the
intermediate goods are perfectly complementary in producing the quality of the
final good; namely,

\[
Q = \min(Q_1, Q_2, \ldots, Q_n),
\]
where \( Q_i \) denotes the quality of the \( i \)th product of the industry and \( Q \) denotes the quality of the final consumption good. In essence, this production function is similar to the ‘O-ring’ production function of Kremer (1993), in which quantity cannot substitute for quality. From the above formulation, it is obvious that all producers of different intermediate products will produce goods with the same quality in equilibrium. So we might as well denote the quality of every intermediate good as well as that of the final good, by \( Q \).

I assume that there is only one factor of production, which is human capital (or efficiency labour). The human capital here can be interpreted as an index of the combination of the level of industrial technology of firms and the level of workers’ educational attainment in the economy. For any intermediate good that is produced, the human capital employed is

\[
(3) \quad h_i = \alpha + \beta Q x_i,
\]

where \( \alpha, \beta \) are both positive constants. It should be noted that the only difference here from the Dixit–Stiglitz model is that I assume that the higher the quality of a product is, the more costly it is to produce it. Specifically, I assume that the quantity and the quality of a product enter symmetrically into its cost function. However, it is easy to verify that other kinds of functional forms can give similar results as long as they have the property that quality is ‘costly’ to produce.

II. A CLOSED ECONOMY

In this section we consider equilibrium in a single economy. Let \( N \) be the total number of individuals of this economy. I assume that every individual in this economy is endowed with amount \( h \) of human capital; so the total amount of human capital in the economy is \( Nh \). Full employment requires that

\[
(4) \quad Nh = \sum_{i=1}^{n} (\alpha + \beta Q x_i).
\]

I assume that the market for the final good is perfectly competitive. Given a quality, \( Q \), let \( P \) be the price of the final good, and \( p_i, i = 1, 2, \ldots, n \), be the prices of intermediate goods. Then, the cost function for final good producers is

\[
\sum_{i=1}^{n} p_i x_i.
\]

Final goods producers seek to minimize their cost for any given amount of output by taking \( P \) and \( p_i (i = 1, 2, \ldots, n) \) as given and choosing the optimal input combination in production function (1). The first-order condition yields

\[
(5) \quad x_i = \left( \frac{p_i}{P} \right)^{1/(\theta-1)} \left( \sum_{i=1}^{n} \frac{x_i^\theta}{\theta} \right)^{1/\theta}.
\]
Meanwhile, the profit for final goods producers is

\[
\pi = PX - \sum_{i=1}^{n} p_i x_i
\]

(6)

\[
= P \left( \frac{\sum_{i=1}^{n} x_i^\theta}{n} \right)^{1/\theta} - \sum_{i=1}^{n} p_i x_i.
\]

Plugging (5) into (6), the zero profit condition of perfect competition in the final good market implies

\[
P = \left( \sum_{i=1}^{n} (p_i)^{\theta/(\theta-1)} \right)^{(\theta-1)/\theta}.
\]

(7)

Now we turn to the problems of the firms producing intermediate goods. Note as long as there are more potential varieties of intermediate goods than are actually produced, there will be no reason for more than one firm to produce any given intermediate good in equilibrium; since the varieties of intermediate goods are symmetrical, a firm will always prefer to switch to a different intermediate good rather than compete with another firm. Thus, each intermediate good will be produced by a monopolist.

Based on the above analysis, let us consider profit-maximizing pricing behaviour of firms. Each individual firm, being small relative to the economy, can ignore the effects of its decisions on the decision of other firms and the total final outputs. Thus, the \(i\)th firm will choose its price to maximize its profits, \(\pi_i\). Taking account of (5) and (1), we have

\[
\pi_i = p_i x_i - (\alpha + \beta Q x_i)w
\]

(8)

\[
= \left( p_i^{\theta/(\theta-1)} - \beta Q w p_i^{1/(\theta-1)} \right) X P^{1/(1-\theta)} - \alpha w
\]

subject to (7), where \(w\) is the cost of one unit of human capital, or the wage rate (of efficiency labour). It should be noted that labour market is perfectly competitive in this model. Consistent with the original Dixit–Stiglitz (1977) model, we assume that any single individual firm is sufficiently small so that its pricing decision for its own product will not affect either the total output (\(X\)) or the price of the final good (\(P\)). So, from the first-order condition, we get

\[
p_i = \frac{\beta Q}{\theta} w.
\]

(9)

Clearly, the price of a product increases as its quality rises.

Next we introduce the possibility of entry and exit. If firms are free to enter to produce new intermediate goods and exit, then profits in the production of \(i\)th intermediate good will be driven to zero. Thus,

\[
\pi_i = p_i x_i - (\alpha + \beta Q x_i)w
\]

(10)

\[
= \frac{\beta Q}{\theta} w x_i - (\alpha + \beta Q x_i)w = 0.
\]
This implies that the output of any intermediate good is

\[ x_i = \frac{\alpha \theta}{\beta Q(1 - \theta)}. \]  

(11)

Thus, the output of any intermediate good that is actually produced decreases as the level of its quality rises. We assume that the labour market is perfectly competitive. So using the full-employment condition, we can then conclude that the number of firms, which is also the number of intermediate goods actually produced, is

\[ n = \frac{Nh}{\alpha + \beta Qx_i} = \frac{Nh(1 - \theta)}{\alpha}. \]  

(12)

This equality indicates that the fixed cost \( \alpha \) limits the number of goods produced. Finally, the total output of the final good is

\[ X = \left( \sum_{i=1}^{n} x_i^0 \right)^{1/\theta} = (nx_i^0)^{1/\theta} = \left[ \left( \frac{\alpha}{1 - \theta} \right)^{1-(1/\theta)\theta} \frac{(Nh)^{1/\theta}}{\beta} \right] \frac{Q}{\beta}. \]  

(13)

For the simplicity of notation, we define

\[ A \equiv \left( \frac{\alpha}{1 - \theta} \right)^{1-(1/\theta)\theta} \frac{Q}{\beta}. \]

Thus, we can express (13) in the following simple form:

\[ X = A \frac{(Nh)^{1/\theta}}{Q} \text{ or } XQ = A \left( Nh \right)^{1/\theta}. \]  

(14)

This equation characterizes the trade-off between the production of the quantity and the quality of the final consumption good in this economy. It is easy to see that the graphical illustration of (14) that depicts the trade-off between quantity and quality will be convex. This result is not surprising if we refer to (3) (imagining the case where only one intermediate good is produced), which introduces the formulation of scale economies into the model.

Next, we investigate the determination of quality. As the market for the final good is perfectly competitive, the quality of the final good is ultimately determined by a representative consumer. Thus, we can derive the quality of the final good (and hence the intermediate goods) by solving the problem of a representative individual’s utility maximization subject to his budget constraint.

First, we derive a representative individual’s budget constraint. Plugging (11) and (12) into (5) and rearranging, we get

\[ p_i = \left( \frac{Nh(1 - \theta)}{\alpha} \right)^{(1-\theta)/\theta} P. \]  

(15)

Plugging (15) into (9), we get

\[ \frac{w}{P} = A \frac{(Nh)^{(1-\theta)/\theta}}{Q}. \]  

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As a representative individual is endowed with amount $h$ of human capital, his real income is $wh/P$.

Then the quantity of an individual’s consumption, which is denoted by $M$, is simply his real income; that is,

$$M = \frac{wh}{P} = A \frac{N^{(1-\theta)/\theta} h^{1/\theta}}{Q},$$

or

$$MQ = AN^{(1-\theta)/\theta} h^{1/\theta}.$$  

Taking the logarithm, we can express the above equation as

$$(16) \quad \ln M + \ln Q = \ln \left( AN^{(1-\theta)/\theta} h^{1/\theta} \right)$$

Equation (16) is the ‘budget constraint’ of a representative individual of the economy, which characterizes the log-linear relationship between the quantity and the quality of consumption.

Now we further discuss an individual’s preferences. To avoid any ‘corner’ solutions, the indifference curves must be more convex than the ‘budget line (or curve)’ generated by (16), which is log-linear. So, we assume that the utility function, $v(M, Q)$, takes the following form:

$$u(\ln M, \ln Q),$$

and we assume that $u(\ , \ )$ satisfies the following properties:\n
$$u_1(\ , \ ) > 0, \quad u_2(\ , \ ) > 0, \quad u_{11}(\ , \ ) < 0,$$

$$u_{22}(\ , \ ) < 0, \quad u_{12}(\ , \ ) > 0. \quad (17)$$

To obtain a closed-form solution of an individual’s utility maximization, we assume that $u(\ , \ )$ is homothetic. Then, given the specified utility function and the budget constraint (16), we can express an individual’s optimal choice of the quantity and the quality of his consumption as

$$(18) \quad \ln M^* = \lambda \ln \left( AN^{(1-\theta)/\theta} h^{1/\theta} \right), \quad \text{and} \quad \ln Q^* = (1 - \lambda) \ln \left( AN^{(1-\theta)/\theta} h^{1/\theta} \right)$$

or

$$(19) \quad M^* = AN^{\lambda(1-\theta)/\theta} h^{\lambda h^{1/\theta}}, \quad \text{and} \quad Q^* = AN^{(1-\lambda)(1-\theta)/\theta} h^{(1-\lambda)/\theta},$$

where $\lambda$ is a constant, $0 < \lambda < 1$. It is clear that the quality as well as the quantity that an individual consumes increases with $h$ and $N$.

The next two sections examine the possibility and consequences of international trade when quality matters. In Section III, we consider the case where the representative individuals of two countries have the same level of human capital. In this case the model shows that full economic integration will occur between the two countries no matter what their relative country sizes are. In Section IV, on the other hand, we see that, if the representative individual’s human capital of an economy is sufficiently low relative to that of the other economy, there may be no trade between the two economies.

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III. TRADE BETWEEN ‘SIMILAR’ COUNTRIES

This section, analysing the trade pattern between economies with the same level of economic development, is based on Krugman (1979) with some modifications. We consider two economies: the home country, with population $N$, and the foreign country, with population $N^*$. Every individual in both countries is endowed with amount $h$ of human capital and has the same preferences.

Suppose that trade is opened between these two economies and at zero transportation cost. In addition, the model assumes an international identity of production functions; that is, every firm in both countries has access to the same production function for producing any intermediate or final goods. In this case, the effect of trade is the same as if each country had experienced an increase in its labour force with homogeneous individual human capital.

Free labour mobility within either country ensures that the wage rate is the same across different firms in the same country. Meanwhile, the assumption of the symmetry of production technology in the two countries will ensure that wage rates will be equal and that the price of any intermediate good produced in either of the two countries will be the same. Otherwise, suppose the wage rate in country A is lower than that in country B; by (9), the price of the intermediate goods produced in country A will be lower than that in country B. So by (5), the demand for any single intermediate good produced in country A will be more than that in country B. However, the zero profit condition ensures that in equilibrium the quantity of any intermediate good will be at a fixed level described by (11). Thus, the wage rate and the price of any intermediate good produced in country A have to increase to be equal to those in country B in order to reach the equilibrium in both labour and goods markets.

Meanwhile, free trade in goods ensures that the same set of intermediate inputs is available everywhere, so that the final goods sectors in both economies achieve the same level of production efficiency (since they can get access to the same production functions described in Section I). Also, the number of intermediate goods produced in each region is determined by the region’s total amount of efficiency labour (or human capital). Moreover, note that, while there are two types of commodity that are potentially traded (the final good and the range of intermediate goods), the emphasis in this paper is on trade in intermediate goods. As no single economy produces the whole range of intermediate goods alone when international trade exists, intermediate goods must be traded. But because it is assumed that the final good is produced through the costless combination of the range of intermediate goods, there is no need for the final good to be traded in this model.

We now examine the determination of product quality when international trade occurs. Suppose that when the two economies are closed the quantity and the quality of the final goods per person in the home country are $M'$ and $Q'$ respectively and those in the foreign country are $M''$ and $Q''$ respectively. We might as well assume $N \leq N^*$. Then, from (19), we know that $M' \leq M''$ and $Q' \leq Q''$. But when international trade becomes possible, producing more than one quality will be inefficient. Because the production function of the quantity of the final good exhibits increasing returns to scale, the quantity of output per worker would be higher than $M''$ when all of the firms in the two countries produce the same quality, $Q''$. Since this switch of production can
increase output and the welfare of every consumer, a profit opportunity exists, and hence entrepreneurship and the force of market competition will result in such a switch. Further, the government can play an active role in facilitating the switch of trade regimes.

As every individual in both countries is endowed with the same amount of human capital and hence income, all individuals face the same budget constraint. Meanwhile, because all individuals in both economies have the same preference, they have the same demand for quality. Then, by a similar logic as above, entrepreneurship and the force of market competition will guarantee that all profit-maximizing firms will produce the quality at the level that maximizes the representative individual’s welfare of the two economies. Thus, the effect of trade is the same as if each country had experienced an increase in its labour force with homogeneous individual human capital. In this case, similar to the analysis in the previous section, we can show that the per capita real income in both countries is

\[ A\left( N + N^*\right)^{(1-\theta)/\theta} h^{1/\theta}, \]

so every individual’s budget constraint becomes

\[ \ln M + \ln Q = \ln \left[ A\left( N + N^*\right)^{(1-\theta)/\theta} h^{1/\theta}\right]. \]

Clearly,

\[ N + N^* > \max(N, N^*). \]

Therefore, the budget constraints of the representative individuals of both countries expand outwards because of the larger scale of the economy, resulting from the further division of labour and international trade. Recalling that we have assumed that \( u(, )\) is homothetic, the per capita consumption of the final good increases to

\[ M^* = A^2\left( N + N^*\right)^{2(1-\theta)/\theta} h^{2/\theta}, \quad \text{and} \]

\[ Q^* = A^{1-\lambda}\left( N + N^*\right)^{(1-\lambda)(1-\theta)/\theta} h^{(1-\lambda)/\theta}. \]

Comparing (19) and (20), we have the following proposition.

**Proposition 1.** The trade between two countries with identical levels of per capita human capital leads to an increase in the per capita consumption of both the quality and the quantity of the final good.

Proposition 1 extends previous studies (e.g. Krugman 1979) by showing that international trade may increase individuals’ consumption of ‘quality’ as well as ‘quantity’ (or ‘variety’). Meanwhile, comparing (19) and (20), we can see that a small economy (e.g. Singapore) benefits more from international trade than a large economy (e.g. the United States).

**IV. NORTH–SOUTH TRADE**

This section analyses the possibility of trade in manufactured goods between two economies with different levels of individual human capital. We may
regard the richer economy as the whole industrial world; so it is both realistic
and convenient to treat the poorer economy as a small economy. We shall
assume that every individual in the richer economy is endowed with one unit of
human capital, that every individual in the small poorer economy is endowed
with $h^s$ amount of human capital, and that

$$h^s < 1$$

We also assume that individuals in this small economy differ from those in the
industrial world only in the endowment of human capital. They share their
preferences with individuals in the rest of the world. Moreover, the firms in this
economy have access to the same production functions of any goods as those in
the rest of the world.

Individuals in this small economy face two options in obtaining the single
final good to consume: one is to produce the good by engaging in international
trade; the other is to produce the good in autarky.

If individuals in the small economy engage in international trade with the
industrial world, as we considered in Section I, they must produce the
intermediate goods with quality $Q_n$ that meets the ‘international standard’
because of the high degree of complementarity of the qualities of intermediate
goods in producing the quality of the final good. We assume, as in the last
section, that there is neither trade barrier nor transport cost. Suppose that the
population of the industrial world is $N$. Then, from the analysis in Section II
(equation (19)), when $h = 1$ we have

$$Q^* = A^{(1-\bar{\alpha})} N^{(1-\bar{\alpha})(1-\theta)/\theta}$$

and the real wage rate in terms of the final good with quality $Q^*$ is

$$w(Q^*) = A^\bar{\alpha} N^{\bar{\alpha}(1-\theta)/\theta}$$

So an individual’s real income of this small economy will be

$$A^\bar{\alpha} N^{\bar{\alpha}(1-\theta)/\theta} h^s.$$  

Thus, if this economy chooses to engage in international trade, its
representative individual’s utility, which is denoted by $U^1$, will be

$$U^1 = u[\ln(w(Q^*)h^s), \ln Q^*]$$

Alternatively, individuals in this small economy can engage in production
in autarky. In this case, they can produce the good of whatever quality they
choose. However, by not taking advantage of international increasing returns,
they face a smaller domestic market size and hence a less efficient aggregate
production technology. Suppose that the populations of this economy and the
industrial world are $K$ and $N$, respectively, and assume that

$$K < N.$$  

Then, similar to the analysis in the previous sections, an individual’s
consumption bundle in this case is

$$M = A^\bar{\alpha} K^{\bar{\alpha}(1-\theta)/\theta} (h^s)^{\bar{\alpha}/\theta},$$

and

$$Q = A^{(1-\bar{\alpha})} K^{(1-\bar{\alpha})(1-\theta)/\theta} (h^s)^{(1-\bar{\alpha})/\theta}.$$  

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Correspondingly, an individual’s utility in autarky, which is denoted by \( U^2 \), is
\[
U^2 = u[\ln(A^{(1-\lambda)/\theta} (h^e)^{\lambda/\theta}), \ln(A^{(1-\lambda)} K^{(1-\lambda)/\theta} (h^r)^{(1-\lambda)/\theta})].
\]
Thus, this small economy will engage in international trade if and only if
\[
U^1 \geq U^2;
\]
that is, if
\[
u[\ln(A^{\lambda} N^{(1-\lambda)/\theta} h^e), \ln(A^{(1-\lambda)} N^{(1-\lambda)(1-\theta)/\theta})] \\
\geq u[\ln(A^{\lambda} K^{\lambda/(1-\theta)} (h^r)^{\lambda/\theta}), \ln(A^{(1-\lambda)} K^{(1-\lambda)/\theta} (h^r)^{(1-\lambda)/\theta})].
\]
As \( K < N \) and \( h^r < 1 \), clearly,
\[
\ln(A^{(1-\lambda)} N^{(1-\lambda)(1-\theta)/\theta}) > \ln(A^{(1-\lambda)} K^{(1-\lambda)(1-\theta)/\theta} (h^r)^{(1-\lambda)/\theta})
\]
that is, the quality of the goods consumed in the rich country is higher than that in the poor country when the poor country chooses to produce in autarky.

So, a sufficient condition for (21) to hold is that the quantity of goods that a representative individual of the poor economy can consume by engaging in trade is greater or equal to that in autarky; that is,
\[
A^{\lambda} N^{(1-\lambda)/\theta} h^e \geq A^{\lambda} K^{\lambda/(1-\theta)} (h^r)^{\lambda/\theta};
\]
that is,
\[
\left( \frac{N}{K} \right)^{\lambda/(1-\theta)} \geq (h^e)^{\lambda-\theta}.
\]
If \( \lambda \geq \theta \), then
\[
(h^e)^{\lambda-\theta} \leq (1)^{\lambda-\theta} = 1.
\]
Meanwhile, as \( N > K \), we have
\[
\left( \frac{N}{K} \right)^{\lambda/(1-\theta)} > (1)^{\lambda/(1-\theta)} = 1.
\]
So if \( \lambda \geq \theta \), (22) always holds. Thus, in this case we always have \( U^1 \geq U^2 \).

On the other hand, if \( \lambda < \theta \), then (22) and (23) are equivalent to
\[
(h^e)^{\lambda-\theta} \geq (1)^{\lambda-\theta} = 1.
\]
In other words, if (24) is satisfied, (22) will hold and hence we will have \( U^1 \geq U^2 \).

In summary of the above analyses, we have the following proposition.

**Proposition 2.** (1) If \( \lambda \geq \theta \), an economy will always choose to engage in international trade.

(2) If \( \lambda < \theta \), an economy will engage in international trade if its representative individual’s human capital is high enough such that (24) is satisfied.

The intuitions of the above results are as follows. (Note that \( \lambda \) represents the proportion of an individual’s expenditure on the quantity of goods, while \( \theta \) \((0 < \theta < 1)\) represents the degree of increasing returns to scale.) When \( \lambda \) is

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greater, individuals of the large rich economy will devote a greater proportion of resources to the consumption of the quantity of the final good. So the conflict of preferences for the ideal quantity and quality between this economy and the rich economy will be smaller. Meanwhile, the smaller \( \theta \) is, the higher degree of increasing returns will be, and hence the more benefits there will be from engaging in international trade. (For example, in the extreme case in which \( \theta = 1 \), the production technology has constant returns to scale so that engaging in international trade will not generate any economic gains.) Thus, when \( \lambda \) is sufficiently large and \( \theta \) is sufficiently small that \( \lambda \geq \theta \), the conflict of preference is relatively small and the benefits of engaging in international trade is relatively large. In this case, any economy, regardless of its average level of human capital, will join the industrial specialization with the large rich economy.

When \( \lambda < \theta \), a sufficient condition that the small economy will engage in international trade is that its average human capital is sufficiently high such that (24) is satisfied. Meanwhile, as \( K < N \), we have

\[
\left( \frac{K}{N} \right)^{\lambda(1-\theta)/(\theta-\lambda)} < 1.
\]

Recall that the representative individual’s human capital of the rich economy is normalized to be 1 in this section. So when \( \lambda < \theta \), the poor economy will choose to engage in international trade before its average level of human capital reaches the average level of the rich economy.

Also, when \( \lambda < \theta \), we have the following results.

**Proposition 3.** (i) If \( \lambda < \theta \) and if the following condition holds,

\[
\left( \frac{K}{N} \right)^{\lambda(1-\theta)/(\theta-\lambda)} > \frac{1}{\theta}
\]

for \( h^c \leq \left( \frac{K}{N} \right)^{\lambda(1-\theta)/(\theta-\lambda)} \), then there exists a threshold level of human capital, \( h^c \), such that an economy will engage in international trade if and only if its representative individual’s human capital is above \( h^c \).

(ii) If \( \lambda < \theta \), and if (25) holds, we have

\[
\frac{dh^c}{dK} > 0.
\]

**Proof.** See Appendix.

The above proposition can be illustrated by the following simulation exercise. Assume that

\[
u(x, y) = xy, \quad A = 1, \quad N = 1000, \quad \lambda = 0.2, \quad \theta = 0.4
\]

Then, we have the following simulation results:

<table>
<thead>
<tr>
<th>( K )</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
<th>350</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>( h^c )</td>
<td>0.1271</td>
<td>0.1350</td>
<td>0.1446</td>
<td>0.1551</td>
<td>0.1663</td>
<td>0.1782</td>
<td>0.1911</td>
<td>0.2049</td>
</tr>
</tbody>
</table>

From the above simulations, we can see that for every value of \( K \) there exists a unique \( h^c \) such that the economy will join the large rich economy in
specialization and exchange if and only if its representative individual’s human capital is greater than $h^c$. Meanwhile, as part (ii) of Proposition 3 predicts, the greater $K$ is, the greater $h^c$ will be, and hence the less likely the economy will engage in international trade.

From the proof in the Appendix, we can see that (25) serves as a sufficient condition for Proposition 3. The intuition for why the technical condition (25) is needed for this proposition is as follows. On one hand, as $h^s$ increases, the ‘distance’ between the poor economy’s ideal quality and the quality of international standard will become smaller. So the poor economy will be more likely to engage in trade. On the other hand, as $h^s$ increases, the domestic market size of the poor economy, which is equal to its per capita human capital (i.e. $h^s$) times its population size, will also increase. So an increase in $h^s$ will increase autarkic production efficiency, but it has only negligible impact on the market size of the global economy as this economy is small. Hence this economy will have less incentive to engage in trade. Thus, when the per capita human capital of this economy is below the level, $(K/N)^{(1-\theta)/(\theta-\lambda)}$, the net effect of an increase in $h^s$ on whether or not the economy will engage in trade can be ambiguous. We therefore need the technical condition (25), which implies that $U_1/U_2$ is a strictly increasing function of $h^s$, to guarantee that $h^c$ is unique.

The intuition of (25) can be explained as follows. The left-hand side of (25) is the ratio of the marginal utility of the quantity of consumption when engaging in trade to that in autarky. When $\lambda < \theta$ and $h^s \leq (K/N)^{(1-\theta)/(\theta-\lambda)}$, an economy will have a smaller quantity of goods to consume if engaging in trade than if producing in autarky. So the law of diminishing marginal utility implies that the ratio on the left-hand side of (25) is greater than 1. Meanwhile, the assumption that quantity and quality are complementary in consumption (i.e. $u_{12}(.,) > 0$) implies that this ratio is even larger, because the quality consumed when engaging in trade is higher than that in autarky. The right-hand side of (25), namely $1/\theta$, measures the degree of increasing returns to scale. The greater $1/\theta$ is, the greater is the impact of an increase in $h^s$ on the domestic production efficiency. Thus, whether (25) is satisfied depends on the properties of the utility function and the production technology.

Proposition 3 suggests that, because of the conflict in choosing the optimal quality of consumption, trade in manufactured goods may not occur between countries with very different levels of per capita human capital and income. When the level of per capita human capital of an economy is sufficiently low relative to that of the rest of the world, individuals in the economy may choose to remain autarkic and produce more of low-quality goods than to join in international industrial specialization to produce fewer high-quality goods. Empirically, for example, Korea and Taiwan both raised their literacy rates greatly in the 1950s, prior to their rapid expansion of exports in manufactured goods in the 1960s (e.g. Wood 1994).

Thus, this model complements the existing literature in explaining the observed trade patterns whereby the bulk of the volume of international trade in manufactured goods is between developed countries with similar endowments. Meanwhile, this model helps formalize Linder’s (1961) hypothesis that the similarity of demand and increasing returns to scale are the major sources of international trade in manufactured goods.
Further, part (ii) of Proposition 3 implies that, *ceteris paribus*, a smaller country is more likely to join in global industrial specialization and to trade in manufactures with advanced countries. The intuition of this result is that a smaller country gains more from taking advantage of international increasing returns to scale because of its smaller domestic market size. This appears to be consistent with the empirical evidence; for example, Alesina and Wacziarg (1997) show that smaller countries are more open to trade. It also sheds light on the observation that in East Asia many smaller economies, e.g. Singapore, Hong Kong, Taiwan and South Korea, joined in global industrial specialization much earlier than some larger economies such as China and India.

The above analysis yields some interesting growth implications. For example, it sheds light on an empirical regularity emphasized by Lucas (1993), i.e. that economies that were growing the fastest would often begin to export some new manufactured goods not exported by them before. Proposition 3 indicates that a poor economy with very low average level of human capital may choose to produce low-quality manufactured goods in autarky. But when the economy gradually develops and the average level of human capital of the economy reaches the threshold level $h^*$, the economy will begin to produce and export high-quality manufactured goods and to engage in international trade. Meanwhile, when an economy just starts to trade in manufactured goods, it tends to grow very quickly because it benefits much from the technological spillover from rich countries (e.g. Coe et al. 1997; Miller and Upadhayay 2000). Empirically, for example, many studies (e.g. Pack and Page 1994; Sengupta and Espana 1994; Dollar and Kraay 2003) show that some East Asian economies have experienced simultaneous rapid growth in both exports and average incomes for several decades.

Moreover, part (ii) of Proposition 3 implies that a smaller country is more likely to engage in international trade in manufactured goods, and hence to benefit from the technological spillover from industrial countries. Thus, a smaller country is likely to experience faster economic growth through engaging in international specialization. This implication complements a result of the ‘big push’ theory. For example, Murphy et al. (1989, p. 537) states that, ‘when world trade is costly, a country can profitably industrialize only if its domestic markets are large enough.’

Finally, the model has an important policy implication. It indicates that developing countries may benefit more from seeking trading opportunities among themselves than from trading with rich countries in their early stages of development. Empirically, we do observe some developing countries actively seeking cooperation among themselves, by establishing free-trade areas and customs unions that are largely composed of developing countries, such as the Latin American Integration Association (LAIA) and the Association of the Southeast Asian Nations (ASEAN).

V. SUMMARY

On the assumption that the qualities of different intermediate goods are highly complementary in producing the quality of the final good, this paper examines the combined roles of quality and increasing returns to scale in international
trade. The model implies that, if the representative individual’s human capital in different countries is similar, individuals in these economies will demand goods of similar quality. In this case the model implies that every country will engage in international trade, which increases the quality as well as the quantity of every individual’s consumption. But if a country’s representative individual’s human capital (and hence income) is low relative to that of the rest of (industrial) world, then individuals in that country will generally have less demand for quality. In this case the analysis shows that an economy will choose to engage in international trade only if the conflict of preference is relatively small and the degree of increasing returns to scale is relatively high.

However, under some circumstances the conflict in the preferences for quality may outweigh the benefit of participating in the global industrial specialization. Under some reasonable conditions, the model implies that there exists a threshold level of human capital such that an economy will engage in international trade if and only if its representative individual’s human capital is above this threshold level. In other words, despite the higher efficiency of international specialization in the production of high-quality goods, individuals in a poor country may find themselves better off by choosing autarky to produce and consume more goods of lower quality, than to be part of the global industrial specialization and consume fewer goods of higher quality.

Because of the disparity in their optimal qualities of consumption, trade in manufactured goods may not occur between countries with very different levels of per capita income. Thus, this paper provides an explanation for the observed trade patterns that the largest volume of international trade in manufactured goods is between developed countries with similar endowments. Meanwhile, this model helps formalize Linder’s (1961) hypothesis that the similarity of demand and increasing returns to scale are the major sources of international trade in manufactured goods. Moreover, the analysis shows that a smaller country is more likely to engage in international trade, because of its smaller domestic market size.

Finally, this paper generates some interesting policy and growth implications. For example, it suggests that developing countries may benefit more from seeking trading opportunities among themselves than from trading with the industrial countries in their early stages of development. Also, the model sheds light on an empirical regularity emphasized by Lucas (1993) that those economies that were growing the fastest would often begin to export some new manufactured goods not exported by them before. Further, the analysis implies that a smaller country is more likely to experience trade-induced rapid economic growth.

APPENDIX

Proof of Proposition 3
(i) We define

\[ G = u[\ln(A^L N^{(1-\theta)/\theta} h^L), \ln((A^{1-\lambda} N^{(1-\lambda)(1-\theta)/\theta})] \]

\[ - u[\ln(A^L K^{(1-\theta)/\theta} (h^L)^{\lambda/\theta}), \ln(A^{1-\lambda} K^{(1-\lambda)(1-0)/\theta} (h^L)^{(1-\lambda)/\theta})] \]

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Then proving part (i) of Proposition 3 is equivalent to proving that there exists a $h^*$ such that $G(h) \geq 0$ if and only if $h \geq h^*$.

First, we try to prove that when $h^* < (\frac{K}{N})^{(\theta-\lambda)/(1-\theta)}$ we have
\[
\frac{dG}{dh^*} > 0.
\]

Note that
\[
\frac{dG}{dh^*} = \frac{1}{h^*} u_1[\ln(A^2 N^{(\theta-\lambda)/(1-\theta)} h^*), \ln(A^{1-\lambda} N^{(1-\lambda)/(1-\theta)} h^*)] - \frac{\lambda}{h^*} u_1[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})]
\]
\[
- \frac{1}{h^*} u_2[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] = \frac{1}{h^*} [u_1[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] - \frac{\lambda}{h^*} u_1[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] - \frac{1}{h^*} u_2[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})].
\]

Because the ‘slope’ of the budget constraint,
\[
\ln M + \ln Q = \ln (\phi h^*),
\]
is equal to $-1$, the first-order condition from an individual’s optimal choice of the quantity and the quality of consumption at autarky entails
\[
u_1[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] = u_2[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})].
\]

So,
\[
\frac{dG}{dh^*} = \frac{1}{h^*} [u_1[\ln(A^2 N^{(\theta-\lambda)/(1-\theta)} h^*), \ln(A^{1-\lambda} N^{(1-\lambda)/(1-\theta)} h^*)] - \frac{1}{h^*} (\lambda + 1 - \lambda) u_1[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] = \frac{1}{h^*} [u_1[\ln(A^2 N^{(\theta-\lambda)/(1-\theta)} h^*), \ln(A^{1-\lambda} N^{(1-\lambda)/(1-\theta)} h^*)] - \frac{1}{h^*} u_2[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})]].
\]

So when condition (25) holds we have
\[
\frac{dG}{dh^*} > 0.
\]

Meanwhile, from Proposition 2, we know $G[(\frac{K}{N})^{(\theta-\lambda)/(\theta-\lambda)}] > 0$. Thus, there exists a $h^*$, $h^* \in [0, (\frac{K}{N})^{(\theta-\lambda)/(\theta-\lambda)}]$, such that $G(h) \geq 0$ if and only if $h \geq h^*$. In other words, there exists a threshold level of human capital, $h^*$, such that an economy will participate in international industrial specialization if and only if the level of the representative individual’s human capital is above $h^*$.

(ii) As $u_1(\theta) > 0$ and $u_2(\theta) > 0$, we have
\[
\frac{dG}{dK} = \frac{\lambda (1-\theta)}{\theta K} u_1[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] - \frac{1-\lambda}{\theta K} u_2[\ln(A^2 K^{(\theta-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)}), \ln(A^{1-\lambda} K^{(1-\lambda)/(1-\theta)} (h^*)^{\lambda/(\theta-\lambda)})] < 0.
\]

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Meanwhile, from \( G(h^c, K) = 0 \), we have
\[
\frac{\partial G}{\partial K} dK + \frac{\partial G}{\partial h^c} dh^c = 0.
\]
From part (i) of this proposition, we know that when condition (25) holds we have \( dG/dh^c > 0 \). Thus,
\[
\frac{dh^c}{dK} = -\frac{dG}{dK} \frac{dG}{dh^c} > 0 \quad \Box
\]

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**NOTES**

1. This paper shares the conclusion of Copeland and Kotwal (1996) and Murphy and Shleifer (1997) that the role of product quality in trade explains why there is little trade in manufactured goods between rich and poor countries. However, while their models are based on a Ricardian framework, this paper derives the results in a model in which trade is caused by increasing returns to scale rather than comparative advantage.

2. Linder (1961, pp. 94, 98, 99) argues that, ‘’[t]he higher the per capita income, the higher will be the degree of quality characterizing the demand structure as a whole. . . [so] similarity of average income level could be used as an index of similarity of demand structures. . . [Therefore], per capita income differences are a potential obstacle to trade (in manufactured goods).’’

3. In fact, if one starts from a general formulation of preferences over a continuum of qualities, we can assume that the total utility takes the form \( v(\text{total quantity, average quality}) \), where \( v(\cdot) \) is strictly increasing with respect to both of its variables. Then, it is easy to see that this formulation would give rise to the consumption of only one quality level in equilibrium because the production function of quantity (for any given quality) exhibits increasing returns (see equation (14), and note that \( 0 < \theta < 1 \)). So, for simplicity, we might as well assume that an individual consumes at the same quality.

4. The result that the equilibrium number of firms does not depend on \( Q \) comes from the simplifying assumption of the symmetry about quality and quantity in production function (i.e. equation (3)). Indeed, in this model an increase in \( Q \) only decreases the quantity produced by each firm (see equation (11)). However, as the total quantity of output is positively related to both the quantity produced by each firm and the number of firms, this modelling strategy will imply that there is a negative correlation between the quantity and the quality in aggregate production and in consumption. Thus, while the change of this assumption of the symmetry may result in both the equilibrium number of companies and the quantity produced by each firm decreasing with \( Q \), this consideration would not change any result of the paper materially.

5. Note that (17) implies that the original utility function, \( v(M, Q) \), satisfies the neoclassical properties:

\[
\frac{\partial^2 v}{\partial M \partial Q} > 0,
\frac{\partial^2 v}{\partial Q \partial M} > 0,
\frac{\partial^2 v}{\partial M^2} u_1 + (\frac{1}{M^2}) u_{11} > 0,
\frac{\partial^2 v}{\partial Q^2} u_2 + (\frac{1}{Q^2}) u_{22} > 0,
\frac{\partial^2 v}{\partial M \partial Q} u_{12} > 0.
\]

6. Matsuyama (1992a) seems to have been the first who introduce entrepreneurship to solve the coordination problem in a model of division of labour.

7. It should be noted that our assumption that the economy is ‘small’ implies that we can ignore the impact of its participation in the global industrial specialization on the determination of the product quality, \( Q^* \), and on the real wage rate in the whole industrial world.

8. Because we assume that the production technologies are the same in rich and poor countries, there is no comparative advantage for either country. Thus, we only need a further (weak) assumption that there is a positive, however small, transport cost in international trade to exclude the possibility that a rich country will produce low-quality

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goods in exchange for high-quality goods from a poor country. At this point it is clear that, if we consider that rich countries have comparative advantages in producing high-quality goods and poor countries have comparative advantages in producing low-quality goods, as in Flam and Helpman (1987), the result of the model is reinforced.

9. By similar logic, another theoretical possibility is that a small and rich country may prefer to be in autarky, while the trade takes place among many poor countries. But this theoretical implication seems to have little empirical relevance in reality and hence is not the focus of this paper.


11. An analogue here is Matsuyama (1992b), who shows that for a closed economy there is positive link between agricultural productivity and growth, while for the small open economy there is a negative link.

12. Several recent papers (e.g. Fischer and Serra 2000; Copeland and Taylor 2001; Francois and van-Ypersele 2002) show that, when quality matters, trade restrictions may raise welfare.

REFERENCES


