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A General Model of Comparative Advantage and the North-South Trade

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Comparative advantage is the most important foundation for world trade. Yet comparative advantage is usually explained by a series of unrelated models. We present a general model that incorporates all three distinct sources of comparative advantage: differences in technologies, differences in factor endowments, and differences in external economies of scale. Apart from being a versatile teaching tool, this model is especially appropriate for describing the trade pattern between developed and developing economies and for analyzing some important issues of trade policy and industrialization relevant for developing economies.

I. Introduction

Comparative advantage is the most important determinant of world trade, especially the trade between developed and developing economies, or the North-South trade. In textbooks on international trade, comparative advantage is usually explained with a series of different models. Each model highlights a different source of comparative advantage. The Ricardian model attributes comparative advantage to the differences in labor productivity, the Heckscher-Ohlin (HO) model to differences in factor endowments, and the model with external economies of scale to the differences in the scale effect. In most empirical studies as well as in theoretical analysis, there is a tendency or presumption to treat different models of comparative advantage only one at a time. For example, studies that attempt to test the HO model rarely pay attention to the role of other factors than the differences in factor endowments.

In the real world, these three sources of comparative advantage are all important. The objective of the present paper is to propose a general trade model that incorporates all three distinct sources of comparative advantage. Though most of the major analytical results are not new, such a model can be a very useful tool for teaching theories of international trade. More importantly, we argue that such a general model of comparative advantage can provide a particularly fitting framework for describing the North-South trade and analyzing issues of trade policy and industrialization relevant for most developing economies.

The paper is organized as follows. In the next section, we explain why a trade model with external economies of scale is still useful and relevant, despite the recent development of trade models with intra-industry trade, internal economies of scale and imperfect

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competition. Then, we present the model in Section III and apply it to analyze the North-South trade in Section IV. The last section offers concluding comments.

II. The Relevance of External Economies of Scale

Economists have long recognized the presence of economies of scale, especially in industry. The existence of economies of scale is widely documented and recently surveyed in Junius (1997). There has long been a perception that diminishing returns are prevalent in agriculture while increasing returns characterize industry. That is why industrialization is the key to economic development because it provides a source for sustained productivity growth. Among industries, there is a general pattern that economies of scale tend to be larger in capital-intensive, skills-intensive or technologically advanced sectors than in labor-intensive sectors. The former tends to be dominated by a few large multinational corporations, while the latter is populated by numerous small-scaled firms.

Though the prevalence of economies of scale in industry, especially in capital-intensive and technologically advanced sectors, has long been recognized, the theoretical work to model economies of scale has been plagued with difficulties. In particular, an extremely vexing implication of economies of scale is that they are inherently incompatible with the market structure of perfect competition, an economists' fiction but nevertheless extremely useful abstraction for most economic theories. The traditional solution to this quandary is to confine what we can analyze to external economies of scale, which is compatible with perfect competition. Ethier (1982) probably represents a last serious attempt at theoretical modeling of the relationship between external economies of scale and trade pattern.

Despite some theoretical weaknesses, the trade model of external economies of scale captures an important aspect of the observed trade pattern. In the real world, small new entrants and large established incumbents do not always compete on an equal footing. In scale-intensive industries, the latter has a clear comparative advantage against the former. That advantage is derived not only from static economies of scale, but also from dynamic economies of scale, which are often called the learning-by-doing effect in other contexts. In other words, larger established producers often enjoy the advantage of high productivity due to their accumulated experience. To the extent that some form of technology is privately owned, it is not always straightforward to distinguish, especially in empirical studies, the scale effect and technological superiority. Though a trade model is usually static by nature, the trade model of external economies of scale should really be interpreted loosely so as to incorporate the effects of both static and dynamic economies of scale.

It is well known that the presence of external economies of scale results in some messy properties. One problem is path dependency. A small initial advantage would be turned into prevailing dominance through the self-reinforcement mechanism. While this property is messier to handle analytically, it captures an essential aspect of the real world in which trade pattern is also influenced by time and history. Another problem is the existence of multiple equilibria. In the context of international trade, the model can explain the resulting trade pattern in terms of the scale effect, but cannot predict a unique initial pattern of trade. Also troublesome is the possibility that among multiple equilibria, the equilibrium that shapes the initial pattern of trade may not be the globally efficient. Despite these known displeasing properties, the trade model of external economies of scale is still relevant and useful.

The 1980s witnessed a surge of interest in developing trade models of internal economies of scale, product differentiation, and imperfect competition. Though these new trade models appear nicer and more sophisticated, they cannot replace the trade model with external economies of scale. This is because such models are mainly designed to explain the nature and structure of intra-industry trade, not to account for inter-industry trade and comparative advantage. While intra-industry trade accounts for an important part of total world trade, especially the trade among developed economies, it is not the only phenomenon generated by economies of scale. Inter-industry trade is also shaped by economies of scale.

Though new trade theories of increasing returns and imperfect competition, especially the popular Helpman-Krugman (1985) model of monopolistic competition and product differentiation, are said to compliment and coexist with the HO model, the integration of these two models is artificial. The integrated model as expounded in Helpman and Krugman (1985) does not explain under what conditions the status of a good can be altered from belonging to intra-industry trade to inter-industry trade. For instance, the passenger car industry is often cited as an example to demonstrate intra-industry trade based product differentiation. But the integrated model cannot account for a puzzling question: why can Korea produce cars and participate in such intra-industry trade among developed economies, whereas Taiwan cannot, even though Taiwan appears to be more developed than Korea in terms of GDP per capita? In sum, new trade theories of internal economies of scale cannot be used to account for inter-industry trade based on comparative advantage and the switch between inter-industry trade and intra-industry trade.

III. A Trade Model with External Economies of Scale

Now we turn to specify our model. Consider a simple trade model with two goods and two factors. Technologies are represented by the Cobb-Douglas production function form for simplicity. Assume that sector 1 is labor-intensive and is characterized by constant returns to scale (CRS). The production function is as follows:

$$S_1 = A_1 K_1^{a_1} L_1^{1-a_1}, \qquad (1)$$

where S_1, K_1, L_1 are the output, capital and labor inputs of sector 1, a_1 is the capital share of cost, and A_1 is the productivity parameter.

In contrast, sector 2 is assumed to be capital-intensive and exhibits external economies of scale. Though there is no well-established theory for the relationship between the capital intensity and scale intensity of a sector, empirical observation suggests (Junius (1997)) that many capital-intensive industries tend to be scale-intensive, too. Specifically, the technology for sector 2 is specified as follows:

$$S_2 = S_2^{e} A_2 K_2^{a_2} L_2^{1-a_2}, \qquad (2)$$

where $0 \le \boldsymbol{e} < 1$ is the scale parameter, S_2, K_2, L_2 are the output, capital and labor inputs of sector 2, $\boldsymbol{a}_2$ is the capital share of cost, and A_2 is the productivity parameter. Rearranging Equation (2), we can see, as shown in Equation (3), that for the sector 2 as a whole, S_2 exhibits increasing returns to scale (IRS) in K_2 and L_2.

$$S_2 = \left(A_2 K_2^{a_2} L_2^{1-a_2}\right)^{\frac{1}{1-e}} . \tag{3}$$

The scale effect we consider here is external. In other words, individual private firms treat the term, S_2^e, as if it is part of the parameter, A_2. Therefore, the private marginal product of labor (*PMP*) is

$$PMP_{L2} = (1-\boldsymbol{a}_2)A_2(K_2/L_2)^{a_2} S_2^e . \tag{4}$$

However, the social marginal product of labor has to include the external scale effect. It is easy to derive the relationship between the private and social marginal products (*SMP*) of factors, for the social marginal product of labor is related to the private marginal product of labor in a simple way, as below:

$$SMP_{L2} = PMP_{L2}/(1-\boldsymbol{e}) . \tag{5}$$

The social and private marginal products of capital can be derived similarly. The present way that the external scale effect is specified does have a convenient property. It implies that the marginal rate of technical substitution (MRTS) is independent of the scale of S_2. In other words, the optimal capital intensity of sector 2 is a function of the wage-rental ratio only, $\boldsymbol{w} = w/r$, just as the optimal capital intensity of sector 1 is. Accordingly, the optimal capital-labor ratios in both sectors depend only on the wage-rental ratio:

$$\frac{(1-\boldsymbol{a}_1)}{\boldsymbol{a}_1}\frac{K_1}{L_1} = \frac{w}{r} = \frac{(1-\boldsymbol{a}_2)}{\boldsymbol{a}_2}\frac{K_2}{L_2} . \tag{6}$$

Equation (6) has two interpretations. One is the optimal condition of cost minimization. The other is that it is the efficient condition that defines the private production possibility frontier (PPF). It means that the ratio of the two marginal products of labor is equalized with the ratio of the two marginal products of capital. Therefore, on the margin, there is no gain for private firms to reallocate either labor or capital from one sector to the other.

Derived from cost minimization, the two unit cost functions corresponding to the two production functions are as follows:

$$p_1 = B_1 w^{1-a_1} r^{a_1} , \tag{7}$$

$$p_2 = B_2 w^{1-a_2} r^{a_2} / S_2^e , \tag{8}$$

where p_i are the two product prices and B_i are scale parameters related to A_i . Equation (6) provides the link between the cost functions, Equations (7)-(8), and the production functions, Equations (1)-(2).

As can be seen, a major consequence of introducing the scale effect is that the unit cost in sector 2 is no longer independent of the scale of S_2, as in the case of sector 1 with CRS. Therefore, the two above equations, Equations (7)-(8), can no longer determine uniquely the two factor prices in terms of the two goods prices, or the other way round.

Taking the ratio of Equations (7)-(8), we get an expression for the relative price of good 2 in terms of good 1,

$$p = p_2 / p_1 = (B_2 / B_1) w^{a_1 - a_2} S_2^{-e} . \tag{9}$$

As will elaborated in Section IV, this equation can be regarded as a general framework for analyzing the determination of comparative advantage by three independent sources. But for the moment, let us continue to specify the rest of the model. As is well known, the factor requirements per unit of output are the same as the derivatives of the two unit cost functions with respect to the two factor prices, w and r, as shown below:

$$a_{L1}(w) = (1 - a_1) B_1 w^{-a_1} , \tag{10}$$

$$a_{K1}(w) = a_1 B_1 w^{1-a_1} , \tag{11}$$

$$a_{L2}(w, S_2) = (1 - a_2) B_2 w^{-a_2} / S_2^{e} , \tag{12}$$

$$a_{K2}(w, S_2) = a_2 B_2 w^{1-a_2} / S_2^{e} . \tag{13}$$

The presence of the scale effect alters the usual shape of the PPF. The PPF is defined as $S_1 = T(S_2)$, the maximum S_1 for a given S_2. Analytically, the PPF is defined by the solution of L_i and K_i , i = 1, 2, from the four equations system consisting of Equation (2) and Equation (6) and the following two equations of factor market equilibrium

$$L_1 + L_2 = L , \tag{14}$$

$$K_1 + K_2 = K . \tag{15}$$

Once L_1 and K_1 are solved for a given S_2, S_1 is given by Equation (1). To make it easier to grasp the implications of the scale effect, we illustrate the properties of the present model with a numerical example shown in Table 1.[1] The values of parameters and exogenous variables are given in the note of Table 1.

1. For general analytical results, see Wong (1995).

The first property to note is that as resources are reallocated from the labor-intensive sector to the capital-intensive sector, the capital intensities of both sectors, k_1 and k_2, decrease correspondingly. In Table 1, the values of S_1, S_2 and k_1, k_2 are shown in Rows 1-2 and Rows 5-6. Reading from left to right, one can see how the structure of the economy changes as S_2 increases from zero to the maximum level. That k_1 and k_2 fall with the increase in S_2/S_1 is a property of the HO model and comes directly from the model structure that the capital intensities of the two sectors are different. As the labor-intensive sector contracts and the capital-intensive sector expands, excess supply of labor and excess demand for capital are generated at the initial capital-labor ratios. Hence, to restore factor market equilibrium, both sectors need to employ more labor-intensive production techniques.

The second property is that as the production methods in both sectors become more labor-intensive (k_1 and k_2 fall), the wage-rental ratio (ω) decreases accordingly as described by Equation (6) and shown in Row 12 of Table 1. In other words, the relative output supply ratio, S_2/S_1, is positively related to the wage-rental ratio, ω. This is also a familiar property of the HO model.

Having established these preliminary results, we can show the main implication of introducing economies of scale: the effect on the slope of the PPF or the relationship between p and S_2/S_1. As is shown in Table 1, as S_2 rises from zero to the maximum, the relative price of good 2 falls first, and then rises as is in the case in a model with CRS. In Table 1, as shown by Row 9, the minimum p is 0.89 corresponding to S_2 = 30.33.[2] In other words, the presence of economies of scale has resulted in multiple equilibria. This is a fairly general implication of introducing external economies of scale into a standard trade model.

What explains the unusual shape of the relative product supply function? Equation (9) provides the clue to the puzzle. In the absence of the scale effect, p is monotonically linked to ω when sector 2 is the capital-intensive sector. As ω falls, p rises. This is what the well-known Stolper-Samuelson theorem describes. Now, on top of that effect, there is a separate scale effect on p through the scale of S_2. The term, S_2^e, falls monotonically with the increase in S_2, pulling down p. However, by its very nature, the effect of S_2^e is more pronounced when S_2 is small than when it is large. Hence, as shown by Table 1, the scale effect outweighs the influence of a falling ω initially, but thereafter, the influence of a falling ω reasserts itself on p, as the scale effect tapers off.

In the market equilibrium, the relative price of good 2, p, is equal to the ratio of the private marginal product of a factor in sector 1 to that in sector 2. However, for the society as a whole, the slope of the PPF, as a measure of the social opportunity cost of producing good 1, is the ratio of the social marginal product of a factor in sector 1 to that in sector 2. As a result, p and $d(S_2/dS_1)$ are related in the following way: $d(S_2/dS_1) = p/(1-e)$. Intuitively, the slope of the PPF is larger than p because the private sector ignores the external scale effect.

Next, we turn to analyze the properties of the GDP function, *i.e.*, the response of the four endogenous variables, S_1, S_2, w, and r to changes in p_1, p_2, L and K. The GDP function (Y) can, of course, be defined in two alternative ways as follows:

2. The minimum value of p is found through numerical minimization.

$$Y(p_1, p_2, K, L) = p_1 S_1 + p_2 S_2 = wL + rK \ . \tag{16}$$

In turn, the equilibrium conditions underlying the GDP function are as follows:

$$p_1 \leq B_1 w^{1-a_1} r^{a_1}, \quad S_1 \geq 0 \,, \tag{7B}$$

$$p_2 \leq B_2 w^{1-a_2} r^{a_2} / S_2^{\,e}, \quad S_2 \geq 0 \,, \tag{8B}$$

$$L_1 + L_2 = L, \quad L_1, L_2 \geq 0, \tag{14B}$$

$$K_1 + K_2 = K, \quad K_1, K_2 \geq 0, \tag{15B}$$

where $L_1 = a_{L1}(w)S_1$ and $K_1 = a_{K1}(w)S_1$, $L_2 = a_{L2}(w; S_2)S_2$ and $K_2 = a_{K2}(w; S_2)S_2$. Row 13 of Table 1 gives the value of GDP with the unit of labor being the *numéraire* ($w = 1.0$).

To complete the model, utility is represented by a simple Cobb-Douglas function:

$$U = D_1^{\,b} D_2^{\,1-b}, \tag{17A}$$

where U is utility, D_1, D_2 are the demands for the two goods, and b is the constant expenditure share of good 1. For some purposes, it is more convenient to express utility in terms of income and prices. The indirect utility function (V) corresponding to Equation (17A) is:

$$V = \left(b^b (1-b)^{1-b}\right) \frac{Y}{p_1^{\,b} \, p_2^{\,1-b}} \ . \tag{17B}$$

In Table 1, Row 14 shows the level of utility. The demands for the two goods can be derived from Equation (17A). Since the derivation is simple and well known, it is omitted here. With the two demands, we can compute the two net export functions that describe the trade pattern. The numerical values of the two net export functions are shown in Rows 3-4. In sum, Rows 1-14 of Table 1 provides a complete description of the model over the entire range of diversification as well as the two limit cases of complete specialization.

How does the present model differ from the HO model? Whereas in the HO model, the set of the perfect competition conditions used to solve w and r is independent of the set of the full employment conditions used to solve S_1 and S_2, the four endogenous variables (w, r, S_1, S_2) must be solved simultaneously fromthese four equations in the present model. In the HO model, the recursive structure makes it possible to separate the Stolper-Samuelson theorem from the Rybczynski theorem. But in the present model, such a separation is no longer valid.

In the presence of multiple equilibria, a tricky issue is to specify how the economy would respond to changes in p. In the present model, there are two reasons why the economy would always prefer the larger scale of S_2 to the smaller scale. This is because, on the one hand, the market equilibrium associated with the larger value of S_2 yields a higher level of welfare, as shown in Row 14 of Table 1. The intuitive explanation for this result is that as S_2

increases, the economy becomes more efficient in that the scale effect makes it feasible to produce more output of the two goods with the fixed factor supplies. With more output and income come higher levels of welfare.

On the other hand, the market equilibrium associated with the larger value of S_2 is also stable in the sense that in the neighborhood of the equilibrium, there is a tendency in the economy to restore the equilibrium. In contrast, the market equilibrium associated with the smaller equilibrium value of S_2 is unstable, because a deviation from it will move the economy either to complete specialization in good 1 or to the larger equilibrium S_2.

These two considerations suggest that in the absence of restrictions, the economy would always choose to produce the larger equilibrium output of S_2 for a given p. In this way, we can resolve the indeterminacy of the relation between goods supplies and prices. The scale of S_2 corresponding to the minimum p can have an intuitive meaning. It can be interpreted as the minimum efficient scale (MES) of S_2 (in Table 1, it is represented by the column for $S_2 = 30.33$). When p falls below that floor, the economy would shift to the limit case of complete specialization in good 1.

It is important to realize that in the present model, the MES of S_2 depends on the magnitude of the Stolper-Samuelson effect, *i.e.*, the relationship between p and w exclusive of the influence of the scale effect. In the absence of such an offsetting Stolper-Samuelson effect, the MES of S_2 is the maximum feasible scale as constrained by the fixed factor supplies of an economy.

In sum, the GDP function can still be concave to the origin in the presence of IRS, if our solution of the multiple equilibria problem is accepted. But there is a qualitative difference between the model with CRS and the model with IRS. In the former, the GDP function is continuous, as S_2 approaches zero and S_1 approaches the maximum specialization limit. But in the latter, the GDP function becomes discontinuous at S_2^{MES} and S_2 jumps to zero from S_2^{MES}.

Having specified how goods supplies respond to changes in goods prices, we can deduce directly the relationship between goods prices and factor prices, as shown by Rows 9 and 12 of Table 1. What happens to the Stolper-Samuelson effect in the present model? We have already shown that w is negatively related to S_2/S_1 through the changes in k_1 and k_2. It follows that like S_2/S_1, w is not a unique function of p. In the range of S_2 from 0 to S_2^{MES}, w is positively related to p. But in the range of S_2 from S_2^{MES} to the maximum feasible scale, w is negatively related to p. Since our solution of the multiple equilibria problem has excluded the combination of a falling p and a rising S_2/S_1 from the equilibrium set of output mix, it also rules out the positive relationship between p and w over the range of $S_2 \in [0, S_2^{MES}]$. Therefore, we conclude that a modified Stolper-Samuelson theorem, *i.e.*, a negative relationship between p and w over the range of $S_2 \in [S_2^{MES}, S_2^{MAX}]$, still applies to the present model.

Turning our attention to real factor prices, it is useful to note that in sector 1, the marginal products of labor and capital depend only on k_1. Therefore, as k_1 falls with the rise in p_2 and S_2, the marginal product of labor (w/p_1) falls and the marginal product of capital (r/p_1) rises in sector 1. In sector 2, the marginal products of the two factors also depend on the scale of S_2. In the case of capital, the falling k_2 and the scale effect of a rising S_2 work in the same direction so that r/p_2 rises unambiguously. But in the case of labor, the falling k_2 and the scale effect of a rising S_2 offset each other. But just as the influence of a falling ω dominates the scale effect in determining p, so does the effect of a falling k_2 on w/p_2.

What happens to the Rybczynski theorem in the present model? The presence of the scale effect alters the standard HO model in two important ways. On the one hand, the factor requirements per unit of output in sector 2 now depend on the scale of S_2. However, if we re-define the output variable to be S_2^{1-e}, then, holding factor prices unchanged, the Rybczynski theorem still applies to S_1 and S_2^{1-e}. An increase in K with L being unchanged would increase S_2^{1-e} and reduce S_1 when the wage-rental ratio, ω, is held constant. It follows that the S_2/S_1 ratio will increase more proportionately with the increase in the K/L ratio.

On the other hand, a change in the scale of S_2 now affects ω. Since the direct effect of a rise in K with an unchanged L is to raise S_2, the effect on ω of a rise in S_2 is similar to that of a rise in p. In other words, ω would fall in response to a rise in S_2. In turn, a fall in ω would induce lower k_1 and k_2. Consequently, the indirect effect through ω reinforces the direct effect, creating excess supply in the capital market and excess demand in the labor market at the unchanged S_1 and S_2. Therefore, to restore equilibrium, S_2 must increase and S_1 decrease at unchanged p. Combining the two separate effects, it follows that a rise in the K/L ratio will raise the S_2/S_1 more than proportionately. In other words, the scale effect reinforces the pure Rybczynski effect.

IV. The North-South Trade

The model presented above is not new. However, it has never been fully appreciated that such a model can be extremely useful as a general theory of comparative advantage with three distinct sources and as a particularly fitting framework for analyzing issues of industrialization relevant to developing countries. In this section, we first illustrate how the present model incorporates three distinct sources of comparative advantage and then apply the model to issues of economic development.

Now suppose that there is a foreign economy with which the home economy trades. Let all the corresponding variables of the foreign economy denoted with '*'. There is an equation corresponding to Equation (8) for the foreign economy. Taking the ratio of the foreign relative product price (p^*) to the domestic relative product price (p), we derive a general expression of comparative advantage.

$$\frac{p^*}{p} = \frac{(B_2^*/B_1^*)}{(B_2/B_1)}\left(\frac{\omega^*}{\omega}\right)^{\alpha_1-\alpha_2}\left(\frac{S_2^*}{S_2}\right)^{-e}. \tag{18}$$

Each of the three terms in Equation (18) denotes a distinct source of comparative advantage: technological differences *à la* the Ricardian model, endowment differences *à la* the HO model, and differences in the scale effect. Let us elaborate each in turn.

Differences in factor endowments determine, in the HO model, a pattern of comparative advantage. Usually, the HO theorem is stated in a model in which there is equalization of factor prices under free trade. The economy with relatively more endowment of capital produces more the capital-intensive good than it consumes. Comparative advantage is reflected in the resulting trade pattern. However, diversification in production and equalization of factor prices are rather special properties of the two goods-two factors textbook model. In more general models, *e.g.*, models with more goods than factors, differences in factor endowments are reflected, as discussed in Xu (1993), in differences in factor prices. The economy endowed with relatively more capital has a higher wage-rental ratio, w, which implies, in turn, a comparative advantage in capital-intensive goods. The more capital-intensive a good is, the more pronounced the comparative advantage in that good of the economy is. In the present model, we can presume that the country with relatively more capital endowment would have a higher w in autarky. Then, Equation (18) tells, *ceteris paribus*, that $w^* > w$ would imply $p^* < p$.

Whereas the Heckscher-Ohlin model assumes that all countries have access to the same technology, the Ricardian model recognizes explicitly that rich countries are more advanced technologically than poor countries. In the well-known Ricardo's example of comparative advantage, England has a comparative advantage in cotton, even though England is less efficient than Portugal in producing both cotton and wine. In textbooks, the Ricardian model usually has only one factor, labor. Though the principle of comparative advantage can be adequately illustrated by way of a one-factor trade model, the Ricardian concept of technological differences-based comparative advantage is a fairly general concept that can be applied to models with any number of factors. It is a gross misconception that the Ricardian model is confined to or handicapped by having only one factor.[3] In the present model, we can allow both $B_1^* < B_1$ and $B_2^* < B_2$. In other words, the foreign economy is more technologically advanced in both sectors than the home economy. But if the foreign economy is relatively more efficient in the capital-intensive sector than the home economy is, *i.e.*, $B_2^* / B_1^* < B_2 / B_1$, then it has, *ceteris paribus*, a comparative advantage in that good, *i.e.*, $p^* < p$. It is important to realize that the Ricardian model and the Heckscher-Ohlin model are not mutually exclusive. They can be complementary to each other because they point to two independent determinants of comparative advantage.

In addition to these two determinants of comparative advantage, the scale effect can be a third independent determinant. If $S_2^* > S_2$, then *ceteris paribus*, it would cause $p^* < p$ so that the foreign economy has a comparative advantage in the scale-intensive good. As explained in Section II, it is better to interpret the scale-induced comparative advantage in terms of the competition between large established incumbents and small new entrants. In the real world, time and history also play a critical role in shaping existing patterns of comparative advantage, even though most theoretical trade models are constructed under a static framework.

In sum, Equation (18) can be regarded as a general expression for the determination of comparative advantage. In the real world, these three determinants of comparative advantage

3. Even Helpman (1999), a distinguished trade economist, has the misconception that the weakness of the Ricardian model is to have only one factor of production.

are all important and relevant in shaping the pattern of world trade. Though in both theoretical work and empirical studies, most of attention in the international trade literature has been given to the HO model, the roles played by the other two determinants of comparative advantage should not be overlooked. However, it is difficult to disentangle empirically the distinct contribution of each factor to the determination of the world trade pattern.

What is the use of the present general model of comparative advantage? Besides offering a neat pedagogical tool to synthesize three distinct theories of comparative advantage, it provides a particularly fitting framework for analyzing the North-South trade. It is obvious that the North-South trade is, by and large, inter-industry trade based on comparative advantage. In terms of the present model, the North trades good 2 for good 1 with the South.

Why does the North have a comparative advantage in good 2? It has long been an undisputed view that the North has comparative advantage in the capital-intensive good and the South in the labor-intensive good. This is because the North has more capital per worker than the South. Reflecting the predominant influence of the HO model, this view is generally consistent with observed empirical regularities.

However, that view does not reflect fully the nature of the North-South trade. It is a gross distortion of reality to pretend that the South is as advanced technologically as the North. Harrigan (1997) has found that the assumption of identical technologies is not valid even among developed economies. In general, it is reasonable to expect that the technological gap between the North and the South is much wider among technologically sophisticated products. Therefore, the North has a comparative advantage in producing technology-intensive products. In this light, the North-South trade can be portrayed as an exchange of high-tech products for low-tech products. Though capital intensity and technology intensity are two separate dimensions of tradable products, it is not too much an exaggeration that the two characteristics are somewhat correlated. In the context of the North-South trade, we can assume that the two indices, $\frac{(B_2^*/B_1^*)}{(B_2/B_1)}$ and $\frac{w^*}{w}$ point to the same direction.

Turning to differences in economies of scale, it is fair to presume, in a general way, that the firms in the South are small and less experienced, while those in the North are large and long established. Being more industrialized, the North has a longer history of producing capital-intensive and scale-intensive goods and thus enjoys a larger scale of production in such goods and benefits from more experience. A particularly fitting example is car manufacturing. Under this perspective, the assumption of $S_2 < S_2^*$ describes well another important difference between the North and the South.

Taken together, these three differences between the North and the South generate a trade pattern that the South trades labor-intensive, low-tech, and less scale-intensive goods for capital-intensive, high-tech, and more scale-intensive goods with the North. Of course, in teaching theories of international trade, we usually make use of small two-sector trade models that highlight the role of one factor at a time. However, there is often a tendency that the view on world trade patterns is unduly constrained by an excessively narrow focus that overshadows numerous empirical trade studies and policy forums. Apart from the three determinants of comparative advantage discussed above, there is another important dimension of the North-South trade that is relevant but difficult to be incorporated in our model. This is the feature that the markets for the exports of developing economies tend to be highly competitive, while those for the exports of developed economies tend to be less competitive and dominated by large multinational corporations.

What kind of policy implications can be drawn from our general model of comparative advantage? Trade economists generally believe in the optimality of free trade for both developed and developing economies. However, there is a widely held feeling among policy makers in developing economies that free trade does not always work to their advantage. The present model provides three sound justifications for an active trade policy in the South to promote and assist capital-, technology-, and scale-intensive sectors.

The presence of the external economies of scale provides the first justification. As is well known in economics, the presence of an externality signifies a market failure. A government action that corrects the market failure would improve economic efficiency. In the present context, the scale of S_2 in the market equilibrium is smaller than what is socially optimal. Therefore, if the South imports good 2, then a tariff on the imports of good 2 may expand the domestic production of good 2 to the socially optimal level. The remedy for such market failures is well understood and does not need further elaboration.

The second justification for an active trade policy is that as an importer of good 2, the South will become worse off under free trade than when it restricts trade. As described above, the South has a comparative disadvantage in good 2 because it has less capital per worker, less technological capacity, produces at a smaller scale. If the South already produces good 2 under protection, trade liberalization would entail in a contraction in the output of good 2 and an expansion in the output of good 1 in the South. But from Table 1, we can see that such a reallocation of resources in the South reduces welfare, instead of raising welfare.

What is the intuition behind this result? Actually, this is a fairly general result from the models that incorporate external economies of scale. In general, a contraction of the scale-intensive sector as a result of free trade will always reduce welfare, so long as the economy remains as a producer of the scale-intensive good. Intuitively, a reduction in the output of the scale-intensive good would always make an economy less technologically efficient due to the scale effect. To put it in another way, the scale effect plays a role similar to shifting the PPF under CRS. As the production of the scale-intensive good contracts, the virtual PPF under CRS shifts inward. That is why the welfare of the South would suffer as a result of moving towards free trade. In sum, the North-South trade in the presence of economies of scale is not mutually beneficial. Trade expansion along the pattern of comparative advantage would always make the world economy more efficient, but the North benefits at the expense of the South.

The above discussion raises a new question: will free trade ever be beneficial to the South? The answer is: it depends. A necessary condition for the South to benefit from free trade in the present model is that it is completely specialized in the labor-intensive good. Furthermore, the terms of trade for the labor-intensive good must be sufficiently favorable to the South. To explain the intuition for this result, let us turn to Table 1. Row 15 shows the level of welfare when the economy is completely specialized in good 1 but can trade at the relative product price shown in Row 9. It is apparent that complete specialization in good 1 is inferior to diversification. This is because diversification derives an efficiency gain from the scale effect in the production of good 2. Further, we can observe in Table 1 that the welfare level associated with complete specialization in good 1 is decreasing monotonically in *p* (or increasing in *1/p*). In Table 1, U_{S1} reaches the maximum (97.49) when *p* is at the minimum (0.89) and S_2 is at the MES (30.33). Further, our numerical optimization shows that if p = 0.88, then U_{S1} would be equal to the utility (98.23) under diversification with S_2 = 30.33. Therefore, unless *p* is equal to or less than 0.88, diversification yields more utility than complete specialization in good 1. In other words, the optimality of free trade that entails in complete specialization in good 1 depends on the terms of trade for the South. If the export price is sufficiently favorable to the South, then the South should be content with producing labor-intensive low-tech products that do not require large scale.

Under what condition is it likely that *p* would be below 0.88, or the terms of trade for the South is sufficiently favorable? There are basically two determinants of the terms of trade for the South. One is the income elasticity of the demand for the good exported by the South. If the income elasticity of the demand for good 1 is sufficiently high, the terms of trade for the South may improve over time with economic growth, or at least do not deteriorate. The other factor is that for a single developing economy, the good it exports does not have close substitutes elsewhere in the world. In other words, the producer enjoys sizeable market power and can extract high mark-ups so that it enjoys favorable terms of trade.

However, common sense suggests that neither of the two scenarios is likely for a typical developing economy. Most of the exports from developing economies are low-end consumer goods and the markets for such goods tend to be highly competitive in terms of price. Therefore, the South may have to live with a *p* that is well above 0.88 (*i.e.*, low prices for their exports of good 1). Given that gloomy outlook for the South's terms of trade, trade liberalization that leads to a contraction in the production of the scale-intensive good or even to complete specialization in good 1 in the South may well be welfare-reducing, contrary to what is predicted by most economists. In essence, the South is entrapped in the pitfall of immiserizing growth. Though trade expansion along the pattern of comparative advantage, in principle, improves the efficiency and welfare of the world economy as a whole, it does not always benefit every economy individually. Specialization in international production is efficient. But it matters critically in what goods an economy becomes specialized. If the South gets locked in producing goods that are less scale-intensive (less potential for productivity improvement) and highly competitive (the terms of trade are more likely to deteriorate), then more trade may not be necessarily beneficial.

The third justification for a supportive trade policy involves the following case. The South is initially completely specialized in good 1. Now the terms of trade for it has worsened such that *p* is larger than 0.88 at least, and may well be above the level (0.89) associated with MES of S_2. Thus, it becomes desirable for that developing economy to get into producing good 2. However, production of good 2 can only expand gradually due to the resource constraint or the learning-by-doing constraint. In other words, instead of jumping to a new equilibrium point on the supply curve of good 2, that developing economy has to move along the supply curve gradually. In that situation, it is obvious that production of good 2 may not be profitable initially when the output scale of good 2 is too small. In other words, good 2 may not be profitable initially, but will be viable when an adequate scale is attained.

In this situation, there is a valid case for government support for sector 2. In a dynamic sense, this is the well-known infant-industry argument. Of course, it is often argued that the infant-industry argument is not valid in the presence of a perfect capital market that is populated with risk-neutral rational investors who can look patiently into the distant future. The spectacular recent stock market boom in the American economy deriving from the confidence in the emerging New Economy driven by the Internet Revolution and information technologies is a good example of what a well-functioning capital market can accomplish. However, a perfect capital market is a feature that most developing economies definitely lack.

There is a further argument for government in the South to support sector 2 when we shift our attention to economic growth. As argued above, the Ricardian technological differences may well be a highly relevant determinant of comparative advantage for the North-South trade. It is very likely that the South is further behind the North technologically in sector 2 than in sector 1. For the South, productivity growth mainly means catching up with the level of technologies attained in the North, not generating inventions and innovations that shift outward the production frontier. On account of Ricardian technological differences, the South is likely to possess, as argued above, comparative advantage in good 1.

Now let us further assume that the larger technological gaps are, the more potential there is for the South to catch up with the North. In other words, the potential for dynamic productivity gains is much larger in sector 2 than in sector 1. This feature is an empirical regularity widely observed in the real world. To the extent that sector 2 possesses more potential for productivity gains than sector 1, government support for sector 2 is warranted.

V. Conclusion

In this paper we present a formal trade model that synthesizes three distinct models of comparative advantage: the Ricardian model, the HO model and the model of external economies of scale. While the three distinct theories of comparative advantage are well known, a general model that incorporates all the three determinants of comparative advantage offers a perspective much richer in content and insights. In particular, as we have illustrated, the present model can present a more realistic picture of the North-South trade and can be used to formalize many important arguments that rationalize a legitimate role for governments in the South to assist and promote industrial upgrading that is essential for sustained growth and development.

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Table 1 Simulation Results

Row	Variable	Symbol	Simulation									
1	The supply of good 1	S_1	184.20	183.07	172.98	162.82	158.54	142.65	100.00	51.95	0.16	0.00
2	The supply of good 2	S_2	0.00	1.00	12.50	25.00	30.33	50.00	100.00	150.00	197.00	197.14
3	Net export of good 1	NX_1		90.97	80.75	70.24	65.73	48.68	0.00	−59.72	−129.03	
4	Net export of good 2	NX_2		−80.18	−87.87	−78.56	−73.65	−53.74	0.00	52.27	98.44	
5	Capital-labor ratio in sector 1	k_1	10.00	9.88	8.90	8.02	7.67	6.53	4.29	2.78	1.84	
6	Capital-labor ratio in sector 2	k_2		53.81	48.48	43.66	41.78	35.53	23.33	15.11	10.01	10.00
7	The price of good 1	p_1	0.78	0.78	0.80	0.83	0.84	0.88	1.00	1.14	1.29	
8	The price of good 2	p_2		0.88	0.74	0.74	0.75	0.80	1.00	1.30	1.69	1.69
9	Relative product price	p		1.13	0.92	0.89	0.89	0.91	1.00	1.14	1.31	
10	The wage rate	w	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	The rental rate	r	0.04	0.04	0.05	0.05	0.06	0.07	0.10	0.15	0.23	0.23
12	Relative factor price	w	23.33	23.06	20.78	18.71	17.91	15.23	10.00	6.48	4.29	4.29
13	GDP	Y	142.86	143.36	148.13	153.44	155.84	165.67	200.00	254.43	333.05	333.33
14	Utility under diversification	U_D		86.47	96.22	97.92	98.23	98.74	100.00	104.47	112.84	
15	Utility under specialization in good 1	U_{S1}		86.46	96.08	97.41	97.49	96.77	92.10	86.16	80.44	

Note: 1. The values of parameters and exogenous variables: $a_1 = 0.3$, $a_2 = 0.7$, $A_1 = 0.92$, $A_2 = 0.23$, $e = 0.1$; $L = 100$, $K = 1{,}000$; $w = 1.0$; $b = 0.5$.
2. The benchmark equilibrium values of endogenous variables: $p_1 = p_2 = 1.0$, $S_1 = S_2 = 100$.