JOURNAL OF ECONOMIC DEVELOPMENT
Volume 27, Number 1, June 2002

Technology Diffusion, North-South Spillovers and Industrial Location

Arsène Rieber and Thi Anh-Dao Tran*

Relying on a model of economic geography, this paper discusses development opportunities arising from international trade and technology diffusion. We show that either import substitution or trade liberalization may trigger takeoff in the developing country, although these two policies work through different mechanisms. The industrialization process is also influenced by knowledge spillovers: strong international technology diffusion offers better prospects for the developing country to benefit from technological externalities provided abroad. Thus, one objective of the developing country should be to enhance its absorptive capacity in order to exploit these technological externalities. In this context, only import substitution trade policy seems to be successful in financing indigenous learning process. However, this result is strongly dependent on the effectiveness of budgetary resource allocation.

I. Introduction

In the debate on development, much attention has been given to the role that international trade plays in explaining long term growth. The successful experiences of the East Asian countries have notably given credence to the belief in a positive relationship between outward orientation and economic development, but without establishing the direction of its causality (Bardhan (1995)). The fast development of the Newly Industrialized Countries (NICs) of East Asia, together with the failure of import substitution in Latin American countries, appeared to show that openness produced unambiguously superior economic performance to its counterpart. Much of the developing world then embarked on trade and industrial policy reforms, and yet failed to exhibit similar growth rates.

A new literature focusing on country studies of South Korea and Taiwan has gained strength and questioned this outward-oriented approach (Amsden (1989), Wade (1990)). Strong evidence is given that both countries pursued import substitution policies that had significant distorting effects, but still maintained remarkable rates of growth of exports, GDP and employment. This alternative approach has then emphasized the role of learning and knowledge accumulation in the East Asian success stories. Nelson and Pack (1999) point out that absorption of increasingly modern technology was instrumental in preventing a decline in the marginal product of capital. Differences in initial knowledge capital also explain why

* CARE, University of Rouen, E-mail: arsene.rieber@univ-rouen.fr and CEPN, University of Paris XIII, E-mail: tranad@seg.univ-paris13.fr, respectively. We would like to thank the editor and the referee for their helpful comments. We are also indebted to Courboin-Thenail Véronique for assistance on earlier drafts of this paper.

the East Asian countries experienced a takeoff while others long stayed in a poverty trap. South Korea and Taiwan had notably created during their stage of import substitution an internal economic and social environment within which the national knowledge-accumulating process was encouraged (Bruton (1998)).

In general, there is a substantial amount of evidence that underlines the importance of international technology diffusion for growth and development. Keller (2001) discusses this concept from the point of view of recent work on endogenous technological change. In this literature, convergence in income turns on the degree of international technology diffusion: because most developing countries spend relatively less on basic science and innovations, they rely even more on foreign sources of productivity growth than richer countries do. According to Keller (2001), the relative importance of foreign technology in Less Developed Countries (LDCs) is at least 90%, and probably higher. In consequence, the greater importance of technology adoption from abroad suggests that learning spillovers might be particularly important for developing countries. Recent empirical investigations confirm that the relative contribution of international technology diffusion to domestic productivity growth is inversely correlated with economic size and the level of development (Coe and *alii* (1997), Meyer (2001)).

Our paper explores this approach in the standard model of new economic geography developed by Krugman and Venables (1995). The new economic geography literature seems to offer a useful way of thinking about development. First, the analysis of economic integration has recognized the major contribution of spatial factors. Meanwhile, a country's capacity to attract industrial activity is increasingly considered as a crucial element of the economic development process. By taking into account the location effect of international integration, the new economic geography literature models economic development as the spread of industry from country to country. Second, interaction between the new economic geography and theories of development stems from the observation that underdevelopment is nothing but the expression of industrial clustering in a few locations (Krugman (1995)). For this reason, part of the economic geography models focus on how economic policies may change the core-periphery pattern. Given the influence of this spatial framework in the debate on development, the economic geography literature may be useful in widening the range of policy options available to the LDCs. By changing the country attractiveness as a base for manufacturing production, economic planners can trigger industrial development.

The two next sections develop the model and focus on a core-periphery structure where industrial production is concentrated in one country. Section IV analyses the role of trade policy in promoting industrialization. Section V provides a discussion on the location effects of international technology diffusion and formalizes the "developmental" role of the State.

II. The Model

Our model is closely related to that of Puga and Venables (1999). Consider a two-country world economy: each country has two sectors (agriculture and industry) and is endowed with given quantities of labor and arable land (respectively L_i and T_i). Both factors are internationally immobile and labor is perfectly mobile between sectors: thus, wage differentials between countries emerge and the spatial dynamics will be provided by firm location.

The agricultural sector is perfectly competitive and produces a homogenous output, chosen as the *numeraire* and assumed costlessly tradable. Its production function is Cobb-Douglas in land and labor and has constant returns to scale. If manufacturing employment in country i is denoted m_i and the labor market clears, agricultural output is given by the expression $(L_i - m_i)^a T_i^{(1-a)}$ and the wage in the economy is written as:

$$w_i = a\left(L_i - m_i\right)^{(a-1)} T_i^{(1-a)} . \tag{1}$$

The industrial sector consists of monopolistically competitive firms producing differentiated goods under increasing returns to scale. The presence of intermediate goods in an imperfect competition context generates forward and backward linkages between firms: each firm produces a variety of industrial good which is both used as inputs by other firms and sold as final goods to consumers. As in Krugman and Venables (1995), we work with a single aggregate manufacturing sector that uses its own output as input. The cost function of an industrial firm in location i is given by:

$$CT_i = \left(e_i + bX_i\right) w_i^{(1-m)} q_i^{m} , \tag{2}$$

where X_i denotes output, e_i is a fixed cost at the origin of increasing returns to scale and b is the quantity of input requirements per unit of output. The input used by industry is a Cobb-Douglas composite of labor and an aggregate of the differentiated industrial goods priced w_i and q_i, with the respective shares $(1-m)$ and m.

The presence of learning and knowledge spillovers implies a decline in the fixed cost element, as the industrial sector expands:

$$e_i = \frac{1}{q_i + l_i(1-q_i)} \ , \quad \text{where } q_i = \frac{n_i}{n_i + n_j} \ , \ \text{i} \neq \text{j and } 0 < l_i < 1 . \tag{3}$$

n_i denotes the number of firms operating in country i and is endogenously determined by free entry and exit; q_i is therefore the share of industrial firms in country i. Equation (3) holds the assumption that industrial firm in location i learns (i.e., accumulates a stock of "knowledge capital" that reduces costs) from manufacturing production both in country i and abroad. Following Baldwin and *alii* (1998), we assume partially localized technological externalities, i.e., $0 < l_i < 1$. Indeed, recent empirical studies indicate that learning spillovers are neither perfect nor nonexistent, implying that international borders seem to dampen the externalities. As the development of foreign industrial sector is weighted by a parameter l_i strictly lower than one, the latter measures country i's ability to assimilate technological knowledge from abroad and will be called the degree of technology diffusion. The higher its value, the more a country absorbs learning spillover effects of cumulative production in the rest of the world. Due to their partial localization, technological externalities are a centripetal force: having more industrial firms in a location reduces the fixed cost, raising profitability of existing firms and stimulating in turn entry of new firms. This centripetal force has a magnitude inversely proportional to the parameter λ_i : the higher the degree of technology diffusion, the less intensive foreign industrial development will play as centripetal force.

Varieties of industrial goods are aggregated in a CES composite good used both as a consumption good and an intermediate input. The price index of this industrial composite in country i takes the following form:

$$q_i = \left[n_i (p_i)^{(1-\sigma)} + n_j (\tau t_i p_j)^{(1-\sigma)} \right]^{\frac{1}{1-\sigma}}, \quad i \neq j, \tag{4}$$

where p_i is the producer price of an individual variety and $\sigma > 1$ the elasticity of substitution between varieties. Real trade costs for the industrial goods take Samuelson's "iceberg" form: $\tau (>1)$ units have to be shipped so that one unit arrives in the other region.[1] An ad valorem tariff $t_i - 1$ $(t_i > 1)$ is levied on industrial goods exported from j to i and produces some fiscal revenue. Hence, an industrial good produced in country j will be sold at price p_j on the home market and at price $\tau t_i p_j$ on the export market i.

Consumers have Cobb-Douglas preferences over the consumption of the agricultural good and that of the composite industrial good, denoted by C_a and C_m respectively:

$$U = C_a^{(1-\gamma)} C_m^{\gamma}, \tag{5}$$

where γ is the share of manufactures in consumer's expenditure. All industrial varieties produced enter consumers' utility function with the same constant elasticity of substitution with which they enter firms' technology.

Expenditures on industrial goods in country i can be derived from Equations (2) and (5):

$$E_i = \gamma \left[w_i m_i + (L_i - m_i)^{\alpha} T_i^{(1-\alpha)} + R_i \right] + \mu n_i C T_i . \tag{6}$$

The first term on the right-hand side is the value of consumer expenditure. In the square brackets, consumer income is divided into three parts: wage income in manufacturing, income generated in agriculture and tariff revenue. For the moment, we work with the assumption that total tariff revenue is distributed to consumers in a lump-sum manner: this assumption will be discussed thereafter. It is also assumed that consumers spend a fraction γ of their income on manufactures. The second term on the right-hand side is the derived demand for intermediates as firms spend a fraction μ of their costs on intermediate goods.

1. τ is viewed as reflecting all costs of doing business abroad out of tariffs. These include transport or shipping costs, costs of providing after-sales services, difficulty of dealing with cultural and language differences.

The demand faced by a firm in country i, hence its output, is either domestic (H_i) or foreign (F_i):

$$X_i = H_i + F_i \,. \tag{7}$$

We can derive the two components of X_i by applying jointly Shephard's lemma and Roy's identity to Equations (2), (4) and (5):

$$H_i = (p_i)^{-s} E_i (q_i)^{s-1} \,, \tag{8}$$

$$F_i = (p_i)^{-s} E_j (q_j)^{s-1} (t t_j)^{1-s} \,. \tag{9}$$

Because every firm faces a price elasticity of demand s, it marks up price over marginal cost by the factor $s/(1-s)$. By choosing units of measurement such that $b = (s-1)/s$, prices are set according to the condition:

$$p_i = w_i^{(1-m)} q_i^{m} \,. \tag{10}$$

The profits made by an individual firm in country i are derived from expressions (2) and (10):

$$p_i = \frac{p_i}{s} \left[\mathrm{X}_i - s e_i \right]. \tag{11}$$

Firms enter and exit in response to short-run profit opportunities. One can define then $\overline{X}_i$ as the long-run level of output giving firms zero profits:

$$\overline{X}_i = s\, e_i \,. \tag{12}$$

The industrial wage bill in country i is the fraction $(1-m)$ of total costs:

$$m_i w_i = (1-m) n_i C T_i \,. \tag{13}$$

The value of tariff revenue in country i is written as:

$$R_i = (t_i - 1) n_j p_j F_j \;,\;\; i \neq j \,. \tag{14}$$

III. The Agglomeration of Industry: A North-South Model

This section applies the model suggested above to the analysis of development problems. The discussion focuses on a core-periphery equilibrium where industrial production is concentrated in one industrialized economy (i.e., the Northern country denoted N) while the other economy (i.e., the Southern country denoted S) has no industrial sector. The following sections aim to determine possible economic policy to be applied by the South to get out of the poverty trap. For that purpose, we seek to understand the forces at work as well as the stability conditions of the North-South pattern. As usual, let us consider profitability of potential firm relocation: if profit opportunities are negative, it is not profitable for a firm to relocate to the South, so the agglomeration equilibrium remains stable. Conversely, if profit opportunities are positive, they act as an incentive for relocation of production to the South.

In order to focus on development policy issues, two additional assumptions must be made: first, the influence of the Northern trade policy is withdrawn from the model by assuming a straightforward free trade policy ($t_N = 1$). So, there is a single trade policy instrument: to simplify further, the Southern trade policy will be denoted $t_S = t$. Second, to abstract from traditional comparative advantage, we assume that both countries have identical factor endowments: $L_i = T_i = A, \ \forall i = N, S$. We do not think that international differences in factors are unimportant but by this assumption, we seek to focus exclusively on the trade flows generated by the agglomeration forces and their influence on industrial location.

At the initial equilibrium, there is no industry and manufacturing employment in the South ($n_S = 0$ and $m_S = 0$). Thus, the wage gap between the North and the South can be derived from expression (1):

$$\frac{w_N}{w_S} = \left(1 - \frac{m_N}{A}\right)^{a-1}. \tag{15}$$

Total expenditure on manufactures is met by output from Northern firms. Since the manufacturing wage bill is a fraction $(1-m)$ of the output value, we have, from (13):

$$m_N w_N = (1-m)(E_N + E_S), \tag{16}$$

where manufacturing expenditure in each country is derived from (6):

$$E_N = g\left[w_N m_N + A\left(1 - \frac{m_N}{A}\right)^{a}\right] + m(E_N + E_S), \tag{17a}$$

$$E_S = g(A + R_S). \tag{17b}$$

Expression (17b) captures the fact that manufacturing expenditure in the Southern economy is totally made of consumers' expenditure and matches agricultural income and tariff revenue.

At the initial equilibrium, the price indices of expression (4) are now reduced to:

$$q_N = (n_N)^{1/(1-s)}\, p_N \,, \tag{18a}$$

$$q_S = (n_S)^{1/(1-s)}\, p_N \; tt \,. \tag{18b}$$

The relations (9), (14) and (18b) enable us to derive tariff revenue in the Southern country:

$$R_S = (t-1)E_S \,. \tag{19}$$

From relations (7) to (9), (17a) and (17b), demand for the output of each firm in the North and for a potential deviant locating in the South take the following forms:

$$X_N = \frac{E_N + E_S}{p_N n_N} \,, \tag{20a}$$

$$X_S = \left(\frac{p_S}{p_N}\right)^{-s} \left[\frac{E_S (tt)^{s-1} + E_N t^{1-s}}{p_N n_N}\right]. \tag{20b}$$

To examine the stability of the agglomeration equilibrium, the profits of a potential entrant in the South are assessed by comparing X_S with its long-run level. The output level corresponding to zero profit is derived from expressions (3) and (12):

$$\overline{X}_N = s \,, \tag{21a}$$

$$\overline{X}_S = \frac{s}{l_S} \,. \tag{21b}$$

The relative prices are derived from relations (10), (18a) and (18b):

$$\left(\frac{p_S}{p_N}\right) = \left(\frac{w_S}{w_N}\right)^{(1-m)} (tt)^m \,. \tag{22}$$

Substituting (20a), (21a) and (22) into expression (20b), the sales of a potential deviant locating in the South are expressed as:

$$X_S = s\left(\frac{w_N}{w_S}\right)^{s(1-m)} (tt)^{-sm} \left[\frac{E_S}{E_N + E_S}(tt)^{s-1} + \frac{E_N}{E_N + E_S}\, t^{1-s}\right]. \tag{23}$$

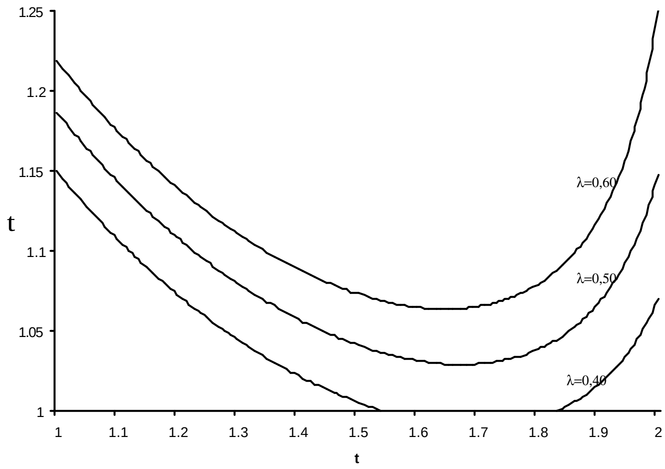
This equation defines the edge of the region in which the Southern economy industrializes: if $X_S > \overline{X}_S$, then profit opportunities are positive, suggesting firms' entry in South. Conversely, when $X_S < \overline{X}_S$, entry in South is unprofitable, involving agglomeration of industry in North.

In addition to technological externalities which act as a centripetal force, the magnitude of X_S is determined by three other forces. The first one is the wage differential, a centrifugal force describing the cost attractiveness of the Southern country. The larger the wage gap between the North and the South (rise of w_N / w_S in expression (23)), the higher X_S, suggesting therefore a more likely take-off in the Southern country. The two other forces capture the pecuniary externalities arising from the input-output linkages between industrial firms. An increase in the output of the downstream industry, by enlarging the market for the intermediates it uses, stimulates sales of the upstream industry. This demand or backward linkage is captured in expression (23) by the square bracket term. In turn, the development of the upstream industry leads to an improvement in intermediate good supply and consequent reduction in production costs of downstream industries. In expression (23), the cost or forward linkage is formalized by the term $(tt)^{-sm}$. Both these forces, through a process of cumulative causation, are centripetal forces and encourage agglomeration.

IV. Trade Policy and Industrialization

The evolution of profit opportunities for a potential firm locating in the South is illustrated in a diagram (t,t). This representation allows us to focus on how the four forces at work determine industrial location and how trade policy may change this determination. Figure 1 is computed using solutions of (15) to (17b), (21b), (23) for various values of import tariff (t). It draws for different degrees of technology diffusion (l_S) a curve along which firms in South earn zero profits: $X_S = s / l_S$. Retaining the line l_S = 0,50 for our comments, it is checked that points for which $X_S > s / l_S$ are located below the line. This locus of points corresponds to the Southern take-off as it is profitable for a manufacturing firm to move to the developing country. The opposite holds for points located above the line.

Several points may be made at this stage of the analysis. First, holding the Southern trade policy constant, movements along the vertical axis introduce a discussion on economic integration (Krugman and Venables (1995)). For a given value of l_S, t captures the forward and backward linkages that undermine take-off in the South. Indeed, since industry is concentrated in North, any potential entrant in South has to pay more for its intermediate inputs than do firms in the North: the extra-cost of intermediates is captured by trade costs and import tariff. Hence, high trade barriers raise the price of intermediates, reducing X_S and profit opportunities in the South. Moreover, by discouraging new entry, trade barriers reduce in turn demand for intermediates and profitability of a potential upstream industry. We have then a circular process in which the Southern economy stays in the poverty trap. A rise of t strengthens these forward and backward linkages (and the stability of the agglomeration equilibrium) while it has no effect on the wage differential, the single centrifugal force. So, Figure 1 highlights the following results:



Values of other parameters are: $a = 0.6, s = 5, g = 0.8, m = 0.8, \mathrm{A} = 1.$

Figure 1 Trade Policy and Industrialization

- When trade costs are high (i.e., a weak international integration), the positive pecuniary externalities created by interfirm linkages are very powerful compared to the wage effects, so that concentration of manufacturing in the North remains stable.
- Inversely, low trade costs diminishes the importance of proximity. As the importance of being close to customers and suppliers declines with the reduction in trade costs, the wage gap becomes the major determinant of industrial location and may induce dispersion.
- When t lies between these extremes, the situation is ambiguous: the equilibrium pattern of location is determined by the value of import tariff.

Thus, for some intermediate position of economic integration, trade policy may be the key to Southern take-off. Starting from a position in which industry is clustered in the North, we can study how the Southern country may use its import tariff to attract industry, namely to change the relative strengths of the forces at work. In this particular model, trade policy is captured by the parameter t. It affects the sales and profitability of a potential deviant locating in South through four channels:

a) Import cost effect (t^{-sm}). By making imported inputs more expensive, tariffs reduce X_S and the profitability of potential industry in the South.

b) Market protection effect (t^{s-1}). By protecting local firms from import competition, a higher t increases the sales and profitability of a potential entrant in the South. This effect captures the benefits of import substitution: the larger t, the higher the proportion of Southern manufacturing expenditure (E_S) spent on Southern firms.

On the other hand, given the assumed distribution of tariff revenue to consumers and devoted by a fraction g to manufacturing expenditure, trade policy induces demand spillover effects both in the North and the South:

c) Demand spillover effects in the South (E_S). When t rises, tariff revenue increases and spurs consumer expenditure on manufactures in the South. In expression (23), the favorable effect on the profitability of a potential entrant in South may be verified with $\partial X_S / \partial E_S > 0$.

d) Demand spillover effects in the North (E_N). Increased expenditure on manufactures in the South also benefits to the North by the purchase of intermediate inputs. According to expression (23): $\partial X_S / \partial E_N < 0$, implying that demand spillover effects in the North decrease short-run profitability of a potential firm located in the developing country.

Whether trade policy can induce industrial relocation to the Southern country depends on the tension between these four effects. While the a) and d) effects point towards trade liberalization to promote takeoff, the other effects b) and c) work in the opposite direction. The U-shaped pattern in Figure 1 indicates that both policies, by influencing the balance between the four effects, may be effective in attracting industry. The originality of such a result, also developed in Puga and Venables (1999), is to go beyond the dichotomy between import substitution and outward-oriented policies usually referred to in the literature.

Finally, Figure 1 illustrates the positive effects international technology diffusion may have on the take-off of developing countries: a higher l_S shifts the curves upwards and enlarges the locus of points in which industrialization may take place. Indeed, an increased degree of technology diffusion offers better prospects for the Southern country to exploit international learning spillovers and raising industry profitability. Analytically, a higher l_S diminishes the long-run level of output (Equation (21b)) and raises the probability for which $X_S > \overline{X}_S$.

V. Assimilation of Technology and Industrialization

According to the above discussion, any change in l_S leads to some development opportunities stemming from technology spillovers, with strong international diffusion favoring take-off. There are big differences in the degree of success that countries have in adopting foreign technology. As emphasized in the theories of endogenous technical change, we view technology as technological knowledge (Aghion and Howitt (1998), Grossman and Helpman (1991)). In this literature, two main determinants of successful technology diffusion have been emphasized: human capital and research and development. Both are associated with the notion of "absorptive capacity", the idea that a firm or a country needs to have a certain type of skill in order to be able to successfully adopt foreign technology knowledge (Keller (1996)).

The process of learning spillovers, particularly in the form of acquisition of tacit knowledge and inter-firm spillover effects of cumulated gross output, has influenced development theory (Bardhan (1995)). It provided strong arguments in favor of the support of the “infant” import-substitution industry and its temporary protection through trade barriers. Such policy helped local firms to absorb technological know-how and benefit from the learning effects of cumulative output. However, the principal reason for the failure of import substitution in Latin America was the non-emergence of the indigenous learning process which underlay technology assimilation (Bruton (1998)). First, as government restrictions on economic activity generated distortions, import substitution strategy created an environment that discouraged learning accumulation and technological progress. Second, these distortions and consequent resource misallocation gave rise to rents of various forms. It was potentially more profitable for entrepreneurs to devote their time and resources to capture such lucrative rents rather than developing technological capabilities.

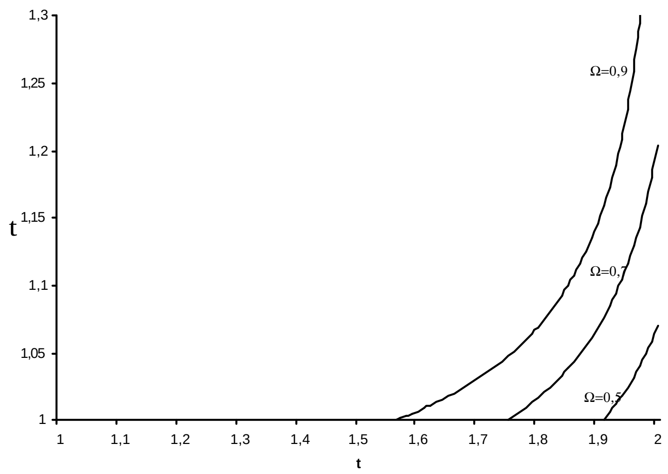
As Lall (1996) noted, the absorption of an increasingly modern technology has been a critical component of the East Asian success stories. The basic feature of South Korea and Taiwan notably was to create an internal social and economic environment within which the national knowledge-accumulating process was encouraged. Such indigenous learning capabilities might be enhanced either through tacit knowledge, learning by doing, or scientific, technical and vocational training.

By enlarging the prospects for the developing country to benefit from technological externalities provided by the North, science and engineering skills are important in facilitating technology diffusion. We set out to show that successful technology diffusion from abroad has to do with a threshold level of human capital. In our particular model, the parameter l_S measures the South’ s ability to learn from the North’ s experience in industrial production; thus, one basic objective of the Southern government should be to rise l_S. The strength of the centripetal force characterizing technological externalities would therefore be weakened. Such a development policy may change the incentives for firms to locate in the country, generating a cumulative process of industrial development. We can illustrate the “developmental” role of the State by endogenizing the technology diffusion parameter according to the value of tariff revenue. We capture the process of learning in a very simple way, by assuming that the South devotes all its tariff revenue to improve the domestic capacity of technological assimilation:

$$l_S = \Omega\left(\frac{R_S}{1+R_S}\right) \quad \text{with} \quad l_S'(\mathrm{R}_S) > 0,\ 0 < l_S < 1 \ \text{ and } \ 0 < \Omega < 1 \ , \tag{24}$$

where Ω measures the effectiveness of tariff revenue allocation in terms of technological absorption. The higher Ω, the more efficiently the developing country absorbs learning spillover effects of cumulated production in the rest of the world.

Unsurprisingly, Figure 2 illustrates the previous results according to which import substitution promotes effectively industrialization in the South; however, trade liberalization no longer appears as an alternative policy. Indeed, given the assumption that tariff revenue is entirely devoted to finance the indigenous learning process, the latter is improved by raising import tariff with all its associated effects already described (market protection, demand spillover effects in the South). Better assimilation of international technology lowers the fixed cost of industrial firms (expression (3)), making the South a more profitable location.



Values of other parameters are: $a = 0.6, s = 5, g = 0.8, m = 0.8, A = 1.$

Figure 2 Technological Assimilation and Industrialization

However, Figure 2 points out also that the success of import substitution is positively related to the effectiveness of tariff revenue allocation, as the curve shifts downwards when Ω decreases. Import substitution policy may be effective in attracting industry, provided that the State orientates effectively its budgetary resources to increase domestic capabilities of technology assimilation. The absence of indigenous learning process and an inefficient resource allocation, illustrated notably by rent-seeking phenomena, can offset the benefits from trade protection.

VI. Conclusion

With the growing analysis of the economic integration process and the emergence *de facto* of a spatial framework in recent literature, the new economic geography has given a whole new insight into development issues. The industrialization process is thought henceforth as the ability of the developing country to attract industrial activity. Given this assumption, part of the economic geography models stress the key role of development policies in determining the equilibrium pattern of location. By influencing the interplay of centripetal and centrifugal forces at work, governments may change the incentives for firms to locate in the developing countries.

In this paper, the analysis has focused on development opportunities provided by international trade and technology diffusion. The results suggest that the international dimension of technological knowledge is of key importance for the LDCs. In this context, technological protectionism from the North or, in the same manner, geographic localization of international technology diffusion, may have detrimental consequences for them. Relying on a model of economic geography, we first rule out the dichotomic approach of import substitution and trade liberalization by concluding that the two policies, through different mechanisms, may be both successful in getting the developing country out of the poverty trap. This result captures the tension between centripetal and centrifugal forces at work in our model: the former arises due to input-output linkages between firms and learning spillovers which create an incentive for manufacturing agglomeration, while the latter is provided by wage differentials. A discussion on the location effects of international technology diffusion has stressed the major contribution of learning and knowledge accumulation to takeoff. We show that strong international technology diffusion changes the attractiveness of countries for manufacturing production and can trigger industrial development. Given this result, one objective of economic planners should be to enhance the learning process that underlies technology absorption. By financing such a process, trade protection enhances the South's ability to learn from the North's experience in industrial production. However, this result is strongly conditioned to the effectiveness of resource allocation: import substitution policy may be effective in attracting industry, provided that the government orientates effectively its budgetary resources to increase the country's absorptive capacity of technology assimilation. The absence of an indigenous learning process and an inefficient resource allocation, illustrated notably by rent-seeking phenomena, offset the benefits from trade protection.

Our model has illustrated most of the major stylized facts of East Asian development. On the one hand, we stand in favor of the "assimilation" theories (as opposed to the "accumulation" theories) which insist on the learning process as an explanatory factor of the rapid industrialization in East Asia. Knowledge accumulation by means of scientific and technical education, the development of new sets of skills or a growing number of well trained managers, engineers and applied scientists facilitated industrialization through the efficient absorption of modern technology (Nelson and Pack (1999)). On the other hand, we set out the view that the discussion about trade orientation is a false problem: as Bruton (1998) suggests, the basic question is the development of a strong indigenous learning process. During their import-substitution stage, South Korea and Taiwan had successfully created an internal economic and social environment within which the national knowledge-accumulating process was encouraged. By avoiding the traditional negative effects of trade protection (budgetary resource misallocation, rent-seeking activities), these countries have induced a reconsideration of import substitution policies.

Then, if the difference does not lie in the mere gap between export orientation and import substitution, why is it commonly advised to LDCs to implement an outward-oriented development? There is evidence that the relative importance of the international technology diffusion has been increasing with the level of economic integration in the world. However, the evidence is not strong enough yet to provide support for export orientation as the best way to boost indigenous learning process. Using data from Colombia, Mexico and Morocco, Clerides and *alii* (1998) focus on technology diffusion related to exports: their paper does not offer strong evidence for domestic learning through exporting. By the same token, the development experiences of the ASEAN-4 countries (Indonesia, Malaysia, the Philippines and Thailand) suggest that simply exporting is not sufficient to result in or to substitute for the creation of an indigenous learning process (Tran (2001)). Concentration of their production and exports on some manufactured goods at the upper and lower ends of the skill and technology range illustrates a largely dual structure, in consequence of insufficient technological and supply linkages between the export sectors and the domestic economy. In particular, the obvious predominance of high-technology exports in Malaysia, the Philippines and Thailand results less from local technological capacities than from a growing division of labour within vertically integrated multinational firms. The dependence on foreign investment in the ASEAN-4 countries has resulted in favorable growth rates, but it questions whether this foreign investment is leading to strong indigenous learning capacity by national firms. Technological knowledge spillovers appear therefore to be resulting from a deliberate commitment to learning: the implicit assumption that simply changing the structure of an economy by means of outward orientation would also change its capacity to accumulate knowledge is evidently incorrect. Development of an indigenous absorptive capacity is a necessary condition for successful technology adoption.

References

Aghion, P., and P. Howitt (1998), *Endogenous Growth Theory*, Cambridge, MIT Press.

Amsden, A. (1989), *Asia's Next Giant: South Korea and Late Industrialization*, New York, Oxford University Press.

Baldwin, R.E., P. Martin, and G.I. Ottaviano (1998), "Global Income Divergence, Trade and Industrialization: The Geography of Growth Take-offs," *NBER Working Paper*, 6458, March.

Bardhan, P. (1995), "The Contribution of Endogenous Growth Theory to the Analysis of Development Problems: An Assessment," in *Handbook of Development Economics*, eds. by J. Behrman and T.N. Srinivasan, Elsevier Science, Vol. IIIB, 2983-2998.

Bruton, H.J. (1998), "A Reconsideration of Import Substitution," *Journal of Economic Literature*, 36, June, 903-936.

Clerides, S., S. Lach, and J. Tybout (1998), "Is Learning by Exporting Important? Micro-dynamic Evidence from Colombia, Mexico, and Morocco," *Quarterly Journal of Economics*, 113, 903-948.

Coe, D., E. Helpman, and A. Hoffmaister (1997), "North-South Spillovers," *Economic Journal*, 107, 134-149.

Grossman, G.M., and E. Helpman (1991), *Innovation and Growth in the Global Economy*, Cambridge, MIT Press.

Keller, W. (1996), "Absorptive Capacity: On the Creation and Acquisition of Technology in Development," *Journal of Development Economics*, 49, 199-227.

_____ (2001), "International Technology Diffusion," *NBER Working Paper*, 8573, October.

Krugman, P. (1995), *Development, Geography and Economic Theory*, Cambridge, MIT Press.

Krugman, P., and A.J. Venables (1995), "Globalization and the Inequality of Nations," *Quarterly Journal of Economics*, 110(4), November, 857-880.

Lall, S. (1996), *Learning from the Asian Tigers*, New York, St Martin's Press.

Meyer, J. (2001), "Technology Diffusion, Human Capital and Economic Growth in Developing Countries," *UNCTAD Working Paper*, 154, June.

Nelson, R.R., and H. Pack (1999), "The Asian Miracle and Modern Growth," *Economic Journal*, 109, July, 416-436.

Puga, D., and A.J. Venables (1999), "Agglomeration and Economic Development: Import Substitution vs. Trade Liberalisation," *Economic Journal*, 109, April, 292-311.

Tran, T.A.D. (2001), "Intra-Asian Trade and Its Role in Amplification of the Economic Crisis," in *Vietnam, Regional Integration and the Asian Financial Crisis,* eds. by V. Houben and M. Grossheim, Department of Southeast Asian Studies, Passau University, 131-161.

Wade, R. (1990), *Governing the Market*. *Economic Theory and the Role of Government in East Asian Industrialization*, New Jersey, Princeton University Press.