INVESTMENT FROM ABROAD AND NATIONAL WELFARE

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

by

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* * * * *

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1985
In Memory of My Mother
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FIELDS OF STUDY

International Economics
Econometrics
Mathematical Economics
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Chapter I
INTRODUCTION

The history of international investment may well date back to the Hanseatic League, which existed in the thirteenth through the seventeenth centuries. After the conquest of the seas with her superior technology in shipbuilding and navigation, England then replaced the Hanseatic League as the center of international investment activity. Thanks to improved communications and transportation and the stability of the gold standard, which facilitated international trade, two billion dollars were invested abroad by European countries between 1815 and 1855. This figure trebled by 1870, was up to 23 billion in 1900, and doubled again by the eve of World War I. The unprecedented upsurge of foreign investment activity in the 1960s and 1970s drove up the stock of direct foreign investment to 511.5 billions in 1980.

The United States was under a significant influence of foreign investment during its process of expansion and industrialization. For instance, in the railroad building industry, overseas shareholders held around one-fourth of all U.S. railroad securities in 1853, and around one-third in 1890. The same pattern of foreign investment activity also occurred in the building of the Canadian Pacific Railway. The reason why this occurred is that the Europeans provided the technology and
management expertise to these massive projects to help guarantee their success. The direction of capital flows reversed after World War I, with the United States replacing European countries as the principal exporter of capital. However, the U.S. dominance in foreign investment has been under challenge since the 1970s.

Some fundamental changes in the pattern of foreign investment have occurred in the post-World War II period. First, the main focus of foreign investment has shifted away from the resource-extracting industries to the manufacturing industries. This trend has been reinforced by the emergence of multinational corporations (MNCs) as well as by the spread of export processing zones in the developing areas since the 1960s. Tables 1 and 2 provide some data showing this shift toward manufacturing. Table 1 shows that, with the exception of Germany, all countries have increased the share of their direct foreign investment in the manufacturing sector during the relevant period. The importance of the extractive sector diminishes in both the United States and the United Kingdom, while it increases in Italy. Table 2, in contrast, shows that manufacturing activities are much more vital in most of the developing countries under consideration. Nigeria is the only country with a higher percentage of direct foreign investment in the extractive sector. Hong Kong is the other extreme, where 100 percent of direct foreign investment goes to the manufacturing sector. Second, with their desire for political independence, rapid industrialization and modernization, more and more developing countries have come to rely on foreign capital, in the form of official aid or
private investment. Many countries changed their official view of foreign investment from passive acceptance to active encouragement. Various incentives such as tax concessions, exemptions of customs duties, generous depreciation allowances, tariff protection, uncontrolled foreign exchange remittances and the provision of infrastructure requirements have been offered to woo foreign firms. One of the most recent examples is China’s Four Modernization Campaign, which encourages investment through either joint ventures or wholly foreign-owned enterprise in almost every area ranging from energy to animal husbandry. Third, despite the increase in the amount of foreign capital in developing countries and the change in attitude towards foreign investment on the part of these countries, the concern over colonialism has never disappeared completely from their consciousness. According to the Latin America dependency school, inward investment can be considered as the basis for a new form of technological dependence which would replace an earlier form of colonial dependence. The concern over technological dependence and unfavorable core-periphery relationships has pushed many developing countries to adopt more sophisticated forms of restrictions. These in general include entry regulations (which specify the sectors and industries where foreign investment is not allowed), local ownership, performance requirements, contents of technology transfer, and so on. Fourth, in contrast to the argument of the two-gap model, more and more developing countries, especially newly industrializing countries (NICs), regard foreign investment today as a vehicle for technology transfer rather than as a source of capital.
This means that these countries tend to make technology acquisition an important objective in their policies toward foreign investment. In some countries such as India, Taiwan, and the Republic of Korea, the transfer of advanced technological knowledge and skills is regarded as the only reason for inviting foreign participation (UNCTC, 1982).

In view of these changes in the reality of foreign investment, the problems faced by the developing countries today are well-defined. Given the world economic order characterized by the scarcity of capital and the lack of indigenous technology in most developing countries, is there any reason why developing countries should not encourage foreign investment? What alternative is there for these countries if foreign investment is precluded as a development strategy? For those countries which have accepted a substantial amount of foreign investment, would they be better off if they stopped any further inflow, or, for that matter, expelled the existing investment? A systematic investigation of these problems is not only interesting from a theoretical point of view, but also important from a practical point of view for policy-makers and private decision-makers in both the developed and developing countries. Since the impact of foreign investment is felt in many facets of social life in a host country, economic considerations alone cannot explain all the implications of these problems. It is worthwhile, however, to investigate what economic analysis can offer in the way of enlightening our understanding of these problems.

In this thesis, we concentrate on a specific aspect of this complex phenomenon called foreign investment. In particular, we investigate
only the welfare effect of foreign investment from the point of view of the host country as a member of the developing world. Some of the existing literature on this subject is briefly reviewed in Chapter II. A sector-specific capital model is set up in Chapter III, which will be used to analyze some comparative static problems in international trade with foreign direct investment. Chapter IV introduces international capital movement and technology transfer into a model of a growing economy to see if there is any benefit for a country to maintain foreign capital in the long-run steady-state. The one-sector growth model discussed in Chapter IV is extended to a two-sector model in Chapter V to study the foreign investment problem in an open economy with commodity trade. Both the import-substituting and export-promoting development strategies are investigated and the results are compared. In Chapter VI, we summarize the major results obtained in this thesis. Some limitations and possible extensions of this study are also indicated.
NOTES

1International investment may refer to any investment capital transfer, including direct as well as portfolio investment (Kemp, 1969). Strictly speaking, however, we are more concerned about direct foreign investment in this thesis.

2For more details about the history of international investment, see Fry (1983). For the positions of foreign investment, see UNCTC (1982) and Goldsbrough (1985).

3The names vary: duty-free zones, export processing zones, free trade zones, free export zones, and manufacturing zones are all in use. There were some 120 such zones set up in the last ten years. (Hamilton and Svensson, 1982).

4Under this open door policy, direct foreign investment increased from almost nil before 1979 up to 5.8 billion in 1982. If foreign borrowing is included, then the number is 12.6 billion. China recently considered opening 14 more coastal cities as well as her onshore oil reserves for foreign investors.


6The impact of foreign investment on the host country's social structure, ethnic stratification, cultural and value systems, arts, literature, and the like are well documented in most dependency literature. For instance, see Apter and Goodman (1976), Kumar (1980), and Newfarmer (1984).
Table 1
Selected developed economies: stock of direct investment in developing countries, extractive vs. manufacturing sector, 1971, and the latest available year

<table>
<thead>
<tr>
<th></th>
<th>1971a</th>
<th></th>
<th>1974a</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Millions of dollars</td>
<td>Percentage</td>
<td>Millions of dollars</td>
<td>Percentage</td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExtractiveC</td>
<td>8,339</td>
<td>36.4</td>
<td>5,191</td>
<td>17.9</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>7,820</td>
<td>34.1</td>
<td>11,362</td>
<td>39.1</td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extractive</td>
<td>1,159</td>
<td>25.7</td>
<td>989</td>
<td>19.6</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1,823</td>
<td>40.5</td>
<td>2,409</td>
<td>47.6</td>
</tr>
<tr>
<td>Germany, Federal Republic of</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extractive</td>
<td>92</td>
<td>4.5</td>
<td>569</td>
<td>9.5</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1,605</td>
<td>78.5</td>
<td>3,633</td>
<td>60.4</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extractive</td>
<td>--</td>
<td>--</td>
<td>1,362</td>
<td>24.0</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>--</td>
<td>--</td>
<td>2,887</td>
<td>50.8</td>
</tr>
<tr>
<td>Italy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extractive</td>
<td>642</td>
<td>53.9</td>
<td>616</td>
<td>57.1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>292</td>
<td>24.2</td>
<td>345</td>
<td>32.0</td>
</tr>
</tbody>
</table>


bAs a percentage of the corresponding country's total direct investment abroad, which includes services and banking.

cRefers to mining, smelting and petroleum.
Table 2

Stock of foreign direct investment by economic activity in selected developing countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Value in millions</th>
<th>Extractive</th>
<th>Manufacturing</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>2,275.2</td>
<td>5.6</td>
<td>65.0</td>
<td>24.5</td>
</tr>
<tr>
<td>1976</td>
<td>9,005.0</td>
<td>2.5</td>
<td>76.5</td>
<td>18.6</td>
</tr>
<tr>
<td>1975</td>
<td>965.0</td>
<td>36.0</td>
<td>44.2</td>
<td>18.3</td>
</tr>
<tr>
<td>1975</td>
<td>4,735.8</td>
<td>4.1</td>
<td>77.5</td>
<td>18.1</td>
</tr>
<tr>
<td>1974</td>
<td>353.5</td>
<td>16.1</td>
<td>37.4</td>
<td>46.4</td>
</tr>
<tr>
<td>1976</td>
<td>1,952.4</td>
<td>--</td>
<td>100.0</td>
<td>--</td>
</tr>
<tr>
<td>1974</td>
<td>1,682.8</td>
<td>4.2</td>
<td>92.0</td>
<td>3.7</td>
</tr>
<tr>
<td>1976</td>
<td>7,077.0</td>
<td>37.5</td>
<td>57.5</td>
<td>10.3</td>
</tr>
<tr>
<td>1976</td>
<td>513.0</td>
<td>12.6</td>
<td>48.7</td>
<td>34.0</td>
</tr>
<tr>
<td>1975</td>
<td>926.9</td>
<td>1.4</td>
<td>80.1</td>
<td>18.5</td>
</tr>
<tr>
<td>1976</td>
<td>3,739.0</td>
<td>40.6</td>
<td>59.3</td>
<td>--</td>
</tr>
<tr>
<td>1975</td>
<td>174.7</td>
<td>--</td>
<td>93.1</td>
<td>6.8</td>
</tr>
<tr>
<td>1974</td>
<td>2,737.7</td>
<td>52.4</td>
<td>33.2</td>
<td>14.4</td>
</tr>
</tbody>
</table>

Chapter II
REVIEW OF THE LITERATURE

Generally speaking, there are two competing hypotheses about the impact of foreign investment in development economics: the "world-system-dependency" hypothesis and the "modernization" hypothesis (Jackman, 1982). The former is generally taken to imply that foreign investment not only depresses economic growth but also leads to the development and acceleration of social inequality within the host country. The core-periphery relationship generated in the host country is considered exploitative since the benefits from investment are more than offset by the excessive profits repatriated to the industrial core. New social groups linked to the core emerge, while the remainder of the periphery population becomes increasingly marginal, resulting in internal distortion and contradiction.

By contrast, the modernization argument implies that foreign investment promotes economic growth by providing external capital, and, through growth, spreads its benefits throughout the economy. It is the presence, rather than the origin, of investment that is considered to be important. Moreover, foreign investment (especially foreign direct investment) usually brings with it advanced new technology, better management and organization, and superior marketing which are of paramount

One of the best analyses about the costs and benefits of foreign investment to developing countries was conducted by Singer (1950). In this pioneering paper, he studied why traditional types of foreign investment have failed to spread industrialization more widely and more evenly throughout the world—a function traditionally ascribed to it (MacDougall, 1960; Johnson, 1972). The main reasons Singer cited are: excessive repatriation of profits by the investing countries, specialization in the activities (such as raw materials and food production) which offer less scope for technical progress, and the secular deterioration in the developing countries' terms of trade.

Singer's arguments were further explored by Prebisch (1959) and Stephen Hymer. While recognizing the potential benefits of international trade and investment, both assert that the unequal distribution of economic and political power will lead to disproportionate share of benefits and costs. Additionally, they point out that the transfer of inappropriate technology, the demonstration of inappropriate consumption behavior, the practice of transfer prices as well as the impact on social and cultural systems, all tend to exacerbate and prolong the disadvantages of developing countries. Thus, in their view, the developing countries will be better off by withdrawing from the international market system, by blocking international trade and investment, or by strictly regulating these activities. The empirical evidence on
this subject remains indeterminate and is still being hotly disputed (Spraos, 1980; Viaene, 1982; Rostow, 1982). In fact, such pessimism had been so widespread during the 1960s and much of the 1970s that plans for economic development adopted by some countries were sometimes based on this Prebisch thesis (or Singer-Prebisch thesis) (Hazari et al., 1981; Goldbrough, 1985).

After Singer's 1950 paper and following Mundell's insight (Mundell, 1957), there developed, roughly speaking, two separate but subtly interrelated lines of research in pure trade theory dealing with this problem. The first one is concerned with the optimal tax (in addition to optimal tariff if one is being imposed) on capital movement (Kemp, 1962a, 1962b, 1966; Jones, 1967; Ramaswami, 1968; Webb, 1970; Das, 1981; Calvo and Wellisz, 1981; Bhagwati and Srinivasan, 1983; Hamilton and Svensson, 1983; Bhagwati and Brecher, 1983). These papers, however, do not address themselves directly to the welfare effect of capital movement but to the equilibrium conditions characterizing a national optimum. The papers belonging to the second line of research deal with the welfare effect of foreign investment on the host country after the repatriation of the capital is made, which is proportional to its marginal product (Arndt, 1957; MacDougall, 1960; Caves, 1971; Bhagwati, 1973; Bhagwati, 1979; Minabe, 1974; Brecher and Diaz Alejandro, 1977; Markusen and Melvin, 1979; Bhagwati and Brecher, 1980; Brecher and Bhagwati, 1981; Brecher and Choudhri, 1982; Brecher, 1982; Viaene, 1982; Brecher and Findlay, 1983; Srinivasan, 1983). Related to this are the papers concerning duty free zones. First investigated by
Hamada (1974), this variation was followed up by Svensson (1981) and Hamilton and Svensson (1982). With the exception of the results obtained by Arndt and MacDougall, which assert that foreign capital is almost always beneficial to the host country, the general theoretical conclusion is that when capital mobility is less than perfect, and hence insufficient to produce the Mundell-type equilibrium (Mundell, 1957), capital inflow can adversely affect the welfare of the host country.

We now turn to the specific contributions of some of the works in the second line of research. Arndt's and MacDougall's studies, though dealing specifically with the Australian case, are general enough to be equally applicable to any host country. Both arrive at similar positive conclusions about the merits of foreign investment in Australia. In Arndt's words, "I think it is quite possible that the benefits, direct and indirect, of overseas investment during the past decade have greatly outweighed the costs, direct and indirect, and will continue to do so." MacDougall's paper is not only the first systematic treatment of this problem, but also by far the most comprehensive one. Based on the marginal productivity analysis, he demonstrates that foreign capital is almost always beneficial to the host country. However, like Singer, MacDougall's complete specialization model is better suited to the more traditional types of foreign investment than what we have today. As pointed out by Brecher and Findlay (1983), a more appropriate framework for this is the familiar Heckscher-Ohlin-Samuelson (H-O-S) two-factor, two-good model. This is exactly the model used by most of the following authors.
In contrast to Bhagwati's original immiserizing growth argument (Bhagwati, 1958), Johnson (1967) and Bertrand and Flatters (1971) showed that capital accumulation in a small country may result in income losses if a tariff is imposed on the capital intensive importing commodity. A similar result was obtained later by Bhagwati (1973), which demonstrated the possibility of immiserizing growth caused by a tariff-induced inflow of capital from abroad provided that the host country is small and continues to import the capital intensive good while remaining incompletely specialized. Brecher's contributions in this connection deserve special attention. With Bhagwati, he proposed that in the presence of foreign-owned factors of production, some standard conclusions in the pure theory of international trade need to be modified. Specifically, he found that with foreign ownership, the absence of the usual foreign and domestic distortions does not ensure that an exogenous terms of trade improvement, exposure to free trade, international transfer or economic expansion will improve national welfare (Bhagwati and Brecher, 1980; Brecher and Bhagwati, 1981). More important to our thesis are the propositions he developed with Diaz Alejandro (1977), which were fully explored later by Bhagwati (1979). These papers strengthened Bhagwati's point (Bhagwati, 1973) by showing that, unless foreign profit tax is taken into account or the inflow of capital is large enough to extinguish the country's imports, reduction in welfare is the only possible outcome from a tariff-induced inflow of foreign investment if the importables are capital-intensive. This negative result was obtained again by Brecher and Findlay later for the
case of an endogenously determined unrestricted inflow of foreign capital (Brecher and Findlay, 1983). Thus, the possibility of immiser-
ization in Johnson (1967) is converted into a necessity if the source of the growth is foreign-owned. This strong conclusion was challenged by Srinivasan (1983). Specifying a specific factor trade model, Srinivasan shows that the welfare effect of the influx of foreign capital is uncer-
tain. Unfortunately, he does not specify the factors determining the direction of welfare change.

All of the papers discussed above employ static (or comparative statics) models. However, investment and development are, by nature, dynamic phenomena. Consider, for example, the phenomenon of technology transfer, which is often cited as one of the most important merits of foreign investment. A proper treatment of technology transfer requires a dynamic model since emulation takes time, as was discussed, for example, by Findlay (1978).

Negishi took an important first step in this direction in his paper of 1965, which was followed by Hamaeda (1966, 1969). Constructing a one-commodity two-country model, Negishi derived the optimal foreign investment in the long run. The most striking result of this work is that when savings are from capitalists only, the optimal policy turns out to be one of subsidizing foreign borrowing. This is in sharp contrast to MacDougall's (1960) and Kemp's (1962a, 1962b) static conclusion that the borrowing country has to exploit its monopsony power and restrict foreign capital inflow by an "optimal tax," a direct application of the optimal tariff analysis. Hamaeda (1966, 1969)
investigated the optimal capital accumulation policy of an open economy. Among his findings, he claims that international capital movements are "not only normal and natural but sometimes desirable for capital importing or exporting countries and for the world as a whole." This is exactly the mirror image of the neoclassical free trade theory. Ruffin (1979), comparing steady state solutions obtained with no capital mobility and with perfect capital mobility, confirmed that there are "gains from capital movement" for both debtor and creditor countries. Bardhan (1967, 1970) and Pitchford (1970) studied the foreign investment problem in the context of an intertemporal optimization model. The possibility of technology transfer via foreign investment was formally incorporated into the international capital movement model by Koizumi and Kopecky (1977), in which they revived the savings rate as a crucial policy variable affecting a country's steady state capital intensity. Findlay (1978) combined Veblen-Gerschenkron's "relative backwardness" hypothesis and the "contagion" idea to formulate a technology transfer mechanism. The upshot is that the stocks of foreign and domestic capital in the host country possess long run equilibrium values that are determined jointly with the technological gap. Another important paper about foreign investment and technology transmission and diffusion is Gehrels' (1983). It arrives at the conclusion that a country normally benefits from the receipt of foreign direct investment, whether or not there is a spillover of technology to domestic firms. When the transfer occurs, it pays to subsidize foreign firms and thus to increase the stock of foreign capital. Gehrels' paper
is particularly interesting in that it is the only paper using a two-way trade model in this area. Contrary to the results of the static models, dynamic models generally conclude that, under some conditions, inward investment is always beneficial to the host country.\(^5\)

The controversies in the empirical studies reflect differences in their theoretical counterpart. Although the results obtained by Papanek (1973), Loo (1977), Bornschier et al. (1978), Biersteker (1978), and Long (1982) brought the developing countries no encouragement, others (e.g. Jackman, 1982; Barrett and Whyte, 1982; Viaene, 1982; Salvatore, 1983) did find support for the development strategy through foreign investment. Recently, the positive effect of foreign capital in transmitting technology were attested by the experience of Taiwan (Schive, 1979), Hong Kong (Chen, 1983a and 1983b), and Mexico (Blomstrom and Persson, 1983). Nevertheless, there are some studies which point to the problem of inappropriate technology and products as argued by the dependence theorists (Biersteker, 1978; Lall, 1978; Long, 1982; Cheng, 1984).

It is clear from the above review that no final verdict has been reached regarding the benefits and costs of foreign investment from either empirical evidence or theoretical analyses. Both merits and demerits can be detected in the works cited above. Reviewing these may constitute a good starting point for this research.

(1) The conflicting conclusions derived from the static analyses are basically caused by different model specifications. Take MacDougall (1960) and Brecher and Diaz Alejandro (1977), for example. In MacDougall's one-commodity model, any inward investment will result in
the decline of the marginal productivity of capital. Since capital is paid by its marginal product, the host country will always gain from the reduction in the rewards to the intramarginal units of foreign capital. In contrast, in Brecher and Diaz Alejandro's two-sector general equilibrium model, the inward investment in the protected capital intensive sector results in an increase in the production of the importables at the expense of the exportables according to the Rybczynski Theorem. This implies a shift of more resources into the inefficient protected sector and thus exacerbates the existing resources misallocation. Moreover, the increase in the production of the importables reduces the amount of imports, which in turn decreases the national income from tariffs. It can be shown that the potential contribution by the inflow of foreign capital definitely falls short of the cost it incurs (Findlay, 1984). Immiserization is therefore ensured in the general equilibrium model.

The question is, therefore, what kind of model is more appropriate for the situation we have today. As pointed out by Brecher and Findlay (1983), the H-O-S model does a fairly good job of capturing the essence of today's foreign investment activities. However, it still ignores a crucial aspect of foreign investment prevalent in many developing countries—the concentration of foreign firms in a few specific sectors (Hamada, 1974; Burgess, 1978; UNCTC, 1983). Thus, it might be useful to modify the H-O-S model to take this feature into consideration (Caves, 1971; Burgess, 1978; Das, 1981; Jones and Dei, 1983; Brecher and Findlay, 1983; Srinivasan, 1983).
(2) In most of the above analyses, the non-traded goods are not taken into account. According to Kravis et al. (1982), almost 45 percent of total expenditure on average was on non-traded goods in a sample of 34 countries in 1975. The percentage is even larger (50.7 percent) for the poorest eight countries in the sample. Since non-traded goods are defined to consist of services and construction, we have a good reason to believe that this percentage actually underestimates the real ratio of non-traded goods in total expenditures in developing countries, given the extensive nonmarket economic activities in the Third World. As is well-known from the international trade literature, the existence of purely domestic industries usually serves as a kind of cushion or reservoir which may absorb the effects from exogenous and/or endogenous disturbances (Kemp, 1969; Hazari et al., 1981; Dornbusch, 1983). Thus, in discussing the national advantage (or disadvantage) from foreign investment, we cannot afford to ignore this important part of the economy.

(3) Despite the well-recognized role of technological innovation and diffusion in the international investment activities, the complexity of this problem has prevented the development of formal theoretical analyses. Up to now, studies of technology transfer have been mostly based on informal arguments and empirical findings (Caves, 1982; Cheng, 1984). Most theoretical treatments of the dynamic open economy model do not incorporate technology transfer. Koizumi and Kopecky (1977), Findlay (1978), and Gehrels (1983) are among the few exceptions. However, the first two do not study the problem in an optimal growth
context. Gehrels' discussion of optimal policies about foreign investment and technology transfer is not very satisfactory, for he does not examine the long-run steady state properties of the economy, though his two-way trade model brings the dynamic analysis more comparable to the static one. Therefore, it is essential that we incorporate the technology transfer mechanism into an open economy optimal growth model if we are to understand the impact of foreign investment in its proper dynamic context.
NOTES

1For reference to Hymer's work, see, for example, Lecraw (1985).

2Some papers on these subjects are collected in Meier (1976), pp. 370-415.

3Under the same assumptions used in the proof of factor price equilization theorem, Mundell (1957) showed that factor mobility is a perfect substitute for commodity mobility, and that the free movement of factors will result in the same equilibrium for both countries as that of free trade.

4The concept of immiserizing growth can be traced back to Edgeworth's damnification effect or even earlier to Scrope as noted by Bloomfield (1981). Bhagwati's argument is associated with the adverse effects of growth on terms of trade, which is different from Johnson's.

5For a detailed discussion of the literature about international technology transfer, see Cheng (1984).

6Exceptions are Burgess (1978), Das (1981), and Srinivasan (1983).

7They are Malawi, Kenya, India, Pakistan, Sri Lanka, Zambia, Thailand, and the Philippines.
Chapter III
FOREIGN INVESTMENT AND NATIONAL WELFARE:
A STATIC APPROACH

A. Introduction

A survey of the literature on foreign direct investment which we
carried out in Chapter II reveals that no final verdict has been reached,
either empirically or theoretically, regarding the benefits and costs of
foreign investment. In the static, general equilibrium model known as
the H-O-S model, inward investment into the tariff-protected capital
intensive sector is invariably detrimental to the host country. In
contrast, the partial equilibrium analysis arrives at the conclusion
that investment from abroad is always beneficial to the host country.
The conclusion derived from the sector-specific models, which take into
account the sector-specific characteristics of foreign investment, lies
somewhere in between. Although some authors, such as Burgess (1978) and
Das (1981), incorporate non-traded goods in their models, they do not
consider specifically the welfare effect of inward investment.\footnote{What is
missing from the literature is an attempt to integrate both the sector-
specific characteristic of foreign investment and the non-traded goods
sector. Given the strategic importance of both non-traded goods and the
sector-specific characteristics of foreign investment in developing}
countries, any model which fails to include either of these elements misses a vital point in the discussion of foreign investment.

In order to capture these elements, we extend Jones' sector-specific model (Jones, 1971) to a three-sector model, with the non-traded goods treated as the third sector. This way, it is hoped, we can obtain a better insight into the mechanism by which the host country's welfare is affected by foreign investment. The technique of comparative static analysis will be employed and our results compared with those obtained by other studies reviewed in Chapter II.

B. The Model

The economy consists of three sectors producing three goods, \( X_1 \), \( X_2 \), and \( X_n \). \( X_1 \) is the exportable good, \( X_2 \) the importable good, and \( X_n \) the non-traded good. Labor is used in, and is mobile between, all three sectors. However, in contrast to the standard trade model, capital is treated as specific to each sector. All three production functions are assumed to exhibit constant returns to scale, positive cross derivatives, and diminishing returns with respect to each factor input. The requirement that all factors be fully employed is given by equations (3.1) to (3.4):

\[
\begin{align*}
     a_{L1}X_1 + a_{L2}X_2 + a_{Ln}X_n &= L \\
     ak_1X_1 &= k_1 \\
     ak_2X_2 &= k_2 = k_d + k_f \\
     ak_nX_n &= k_n,
\end{align*}
\]  

(3.1) (3.2) (3.3) (3.4)
where \( a_{ij} \) is the amount of factor \( i \) employed per unit of \( X_j \) produced. (In this chapter, the subscripts \( i \) and \( j \) always represent \( i=K, L \) and \( j = 1, 2, n \).) \( K_f \) is the capital invested by foreigners. The domestic endowments of labor and three different kinds of capital are denoted by \( L, K_1, K_d \) and \( K_n \), respectively. Under the assumptions that all commodities are produced and all markets are perfectly competitive, the unit costs must be reflected in market prices. We thus have equations (3.5) to (3.7):

\[
\begin{align*}
  a_{L1}w + a_{k1}r_1 &= P_1 \Xi 1 \quad (3.5) \\
  a_{L2}w + a_{k2}r_2 &= P_2 \quad (3.6) \\
  a_{Ln}w + a_{kn}r_n &= P_n, \quad (3.7)
\end{align*}
\]

where \( P_j, w, \) and \( r_j \) are the price of the \( j \)th commodity, wage rate, and rental on capital in the \( j \)th sector, respectively, all in terms of \( X_1 \). \( X_1 \) is treated as the numeraire, with \( P_1 \) normalized to 1. The market equilibrium conditions are

\[
\begin{align*}
  X_1 &= D_1 + E_1 \quad (3.8) \\
  Y_2 &= D_2 - M_2 \quad (3.9) \\
  X_n &= D_n. \quad (3.10)
\end{align*}
\]

\( D_j \) is the domestic demand for the \( j \)th goods; \( E_1 \) is the export and \( M_2 \), the import. The economy's budget constraint is

\[
X_1 + P_2X_2 + P_nX_n + \frac{\tau}{1+\tau} P_2M_2 - r_2K_f = D_1 + P_2D_2 + P_nD_n \quad (3.11)
\]
where $\tau$ is the rate of import tariff.

Assume that a well-behaved community utility function exists as expressed in (3.12).

\[ U = U (D_1, D_2, D_n). \quad (3.12) \]

Utility maximization assures the following relationship:

\[ U_1 = \frac{U_2}{P_2} = \frac{U_n}{P_n}, \quad (3.13) \]

where $U_j = \frac{\partial U}{\partial D_j}$ is the marginal utility of the $j$th commodity. Since we are considering a small country, the domestic price of importable, $P_2$, is fixed through the relation $P_2 = (1+\tau)\bar{p}$, where $\bar{p}$ is exogenously given. Finally, with perfect competition ensuring the minimization of the unit cost, all the $a_{ij}$'s depend on the factor price ratio in sector $j$

\[ a_{ij} = a_{ij}(w/r_j). \quad (3.14) \]

Some features of the model deserve brief discussion.

(1) Sector specific capital is adopted to highlight the fact that direct foreign investment, especially in developing countries, tends to be concentrated in some specific sector. This might be due to an economic consideration as suggested by Caves (1971, 1982). However, an institutional restriction or a political consideration in the host
country might play an even more crucial role. In fact, the activity in the export processing zone is a typical example of the sector-specific investment (Hamada, 1974; Hamilton and Svensson, 1983).

(2) The inclusion of a non-tradable commodity makes the model closer to reality as stated in Chapter II. In any case, the inward investment into the traded goods sector will result in resource reallocation and thus the existing non-traded goods sector should react to it. The change in the relative price of the non-traded goods will unavoidably influence the final effect of foreign investment. Moreover, although Burgess (1978) and Das (1981) both use similar models in studying the effect of foreign investment on income distribution and employment, their models incorporate only two sectors—the non-traded goods sector and the exportable sector. Thus they fail to take into consideration the possible impact of tariffs. In this model we explicitly introduce the importable sector to capture the distortionary effects of tariffs on the domestic economy.

C. The Effect of Foreign Investment

Suppose now the initial equilibrium is disturbed by an inflow of foreign capital into the importable sector. The effects on factor returns owing to such an inflow of foreign capital can be derived as follows.

Totally differentiating (3.5) - (3.7) and making use of the cost minimization conditions
\[ \sum_{j} \dot{a}_{Lj} \dot{a}_{Lj} + \sum_{k} \dot{a}_{kj} \dot{a}_{kj} = 0, \]  

(3.15)

we get

\[ \dot{a}_{L1} \dot{w} + \dot{a}_{kJ} \dot{r}_1 = 0 \]  

(3.16)

\[ \dot{a}_{L2} \dot{w} + \dot{a}_{kJ} \dot{r}_2 = 0 \]  

(3.17)

\[ \dot{a}_{Ln} \dot{w} + \dot{a}_{kJ} \dot{r}_n = \dot{p}_n, \]  

(3.18)

where the circumflex (\(^\cdot\)) denotes the relative change of the variable and

\[ \dot{a}_{Lj} = w a_{Lj} / p_j : \text{ the proportion of total cost of the jth sector spent on labor} \]

\[ \dot{a}_{kJ} = r_j a_{kj} / p_j : \text{ the proportion of total cost of the jth sector spent on capital.} \]

Substituting (3.2) - (3.4) into (3.1), we obtain

\[
\frac{a_{L1}}{a_{kJ}} \frac{\dot{K}_1}{\dot{K}_j} + \frac{a_{L2}}{a_{kJ}} (\dot{K}_d + \dot{K}_F) + \frac{a_{Ln}}{a_{kJ}} \dot{K}_n = \dot{L}. 
\]  

(3.19)

Differentiating (3.19) totally and using the definition of \( a_j \), elasticity of substitution between capital and labor in sector \( j \),
\[ \sigma_j = \frac{\hat{a}_{Lj} - \hat{a}_{kj}}{\hat{r}_j - \hat{w}} \]

we have

\[ \lambda_{L1} \hat{r}_1 + \lambda_{L2} \hat{r}_2 + \lambda_{Ln} \hat{r}_n - (\lambda_{L1} \sigma_1 + \lambda_{L2} \sigma_2 + \lambda_{Ln} \sigma_n) \hat{w} = - \lambda_{L2} \alpha K_f, \]

(3.20)

where \( \lambda_{Lj} = \frac{a_{Lj}}{X_j / L} \): the fraction of labor force used in the production of goods \( j \)

\( \alpha = K_f / (K_d + K_f) \): the proportion of foreign capital in the importable sector.

Substituting (3.16) - (3.18) into (3.20) and solving for \( \hat{w} \), we have

\[ \hat{w} = S_n \hat{p}_n + \frac{\lambda_{L2}}{\Delta} \alpha K_f, \]

(3.21)

where

\[ \Delta = \lambda_{L1} \frac{\sigma_1}{\theta_{k1}} + \lambda_{L2} \frac{\sigma_2}{\theta_{k2}} + \lambda \frac{\sigma_n}{Ln \theta_{kn}} \]

and

\[ S_j = \left( \lambda_{Lj} \frac{\sigma_j}{\theta_{kj}} \right) / \Delta. \]
Therefore, from (3.15) - (3.18) and (3.21), we obtain the following:

\[ \hat{r}_1 = -S_n \frac{\theta_{L1}}{\theta_{k1}} \hat{p}_n - \alpha S_1 \frac{\theta_{L1}}{\sigma_1} \frac{\lambda_{L1}}{\lambda_{L1}} \hat{K}_f \]  
(3.22)

\[ \hat{r}_2 = -S_n \frac{\theta_{L2}}{\theta_{k2}} \hat{p}_n - \alpha S_2 \frac{\theta_{L2}}{\sigma_2} \hat{K}_f \]  
(3.23)

\[ \hat{r}_n = \frac{1}{\theta_{kn}} (1 - S_n \theta_{Ln}) \hat{p}_n - \alpha S_n \frac{\theta_{Ln}}{\sigma_n} \frac{\lambda_{L2}}{\lambda_{Ln}} \hat{K}_f . \]  
(3.24)

As shown by Jones (1971), \( \sigma_j / \theta_{kj} \) is nothing but the elasticity of the marginal product curve of labor in sector j. Thus, \( \Delta \) is a weighted average of these elasticities.

The implications of (3.21) to (3.24) are not difficult to grasp. With the linearly homogenous production function, the rewards to the factors are determined by the capital-labor ratio in the sector in which they are employed. The increase of foreign investment in sector two results in a higher capital-labor ratio, and therefore raises wages and reduces rentals if the relative price does not change. This will induce labor to move to sector two, and the capital-labor ratios in the other two sectors will go up which, in turn, cause \( \hat{r}_1 \) and \( \hat{r}_n \) to go down. These can easily be obtained by letting \( p_n = 0 \) in (3.21) to (3.24). However, \( p_n \) (which is determined by the demand and supply of the non-traded goods) can remain unchanged only in a very special situation. Under fixed \( p_n \), supply of \( x_n \) will decrease because labor is moving out of this sector, and demand will be influenced by the change in income.
Unless the income effect causes the demand for non-traded goods to decrease by the same amount as that of supply, $P_n$ has to adjust to clear the non-traded goods market. As $P_n$ moves to its new equilibrium, a second round of labor reallocation takes place. Hence, the final equilibrium levels of wage and rentals cannot be determined until we determine the sign of $\hat{P}_n$. In order to do this, we have to look at the effect of new foreign capital on the outputs of all sectors and thus its impact on national income.

From the definition of the elasticity of substitution and (3.15), we have

$$\hat{a}_{kl} = \hat{a}_{L1} - \sigma_1 (r_1 - w)$$

$$= - \frac{\theta_{kl}}{\theta_{L1}} \hat{a}_{kl} - \sigma_1 (r_1 - w)$$

From this it follows that

$$\hat{a}_{kl} = - \sigma_1 \theta_{L1} (r_1 - w). \quad (3.25)$$

Logarithmically differentiating (3.2) and using (3.25), (3.21) and (3.22), we get

$$\dot{X}_1 = - \dot{a}_{kl} = \sigma_1 \theta_{L1} (r_1 - w)$$

$$= - \sigma_1 S_n \frac{\theta_{L1}}{\theta_{kl}} \hat{P}_n - \alpha S_L \theta_{L1} \frac{\lambda_{L2}}{\lambda_{L1}} \dot{K}_f \quad (3.26)$$
Similarly, we can obtain \( \hat{x}_2 \) and \( \hat{x}_n \) as follows:

\[
\hat{x}_2 = \alpha(1 - \theta L_2 S_2) K_f - \sigma_2 S_n \frac{\theta L_2}{\theta k_2} \hat{p}_n 
\]

\[
\hat{x}_n = \sigma_n (1 - S_n) \frac{\theta L_n}{\theta k_n} \hat{p}_n - \alpha \theta L_n S_n \frac{\lambda L_2}{\xi L_n} K_f 
\]

(3.27)

(3.28)

The mechanism we described above makes interpreting these outcomes straightforward. The initial impact of new foreign capital is to increase \( x_2 \) and to reduce \( x_1 \) and \( x_n \); the second round of labor movement depends upon \( \hat{p}_n \).

Let national income, \( I \), be defined as

\[
I = x_1 + P_2 x_2 + P_n x_n + \frac{\tau}{1 + \tau} P_2 M_2 - r_2 K_f 
\]

(3.29)

Logarithmically differentiating (3.29) gives us

\[
\hat{I} = \delta_1 \hat{x}_1 + \delta_2 \hat{x}_2 + \delta_n \hat{x}_n + \delta_n \hat{p}_n + \delta_1 \hat{M}_2 - \delta_2 \delta_f (K_f + r_2) 
\]

(3.30)

where \( \delta_j = \frac{\partial I}{\partial j} / I \): the share of the jth sector in the national income

\[
\delta_T = \frac{\tau}{1 + \tau} P_2 M_2 / I \quad : \quad \text{the share of tariff revenue in national income} 
\]
$\delta_f = r_2 K_f / P_2 X_2$ : the proportion of rewards to foreign capital as of the output of sector two.

We need $\dot{M}_2$ to evaluate (3.30). The behavior assumption about the importable market is given by

$$M_2 = D_2(P_n, I) - X_2(P_n, K_2) \tag{3.31}$$

From (3.31), we get $\dot{M}_2$ as follows:

$$\dot{M}_2 = [e_{2n} + \frac{X_2}{M_2} (e_{2n} - \xi_{2n})] \dot{p}_n - a \xi_{2k} \frac{X_2}{M_2} K_f + \frac{m_2 I}{P_2 M_2} \dot{I} \tag{3.32}$$

The meanings of the symbols are:

$e_{2n} = \frac{a D_2}{a P_n D_2} P_n$: the demand elasticity of importables with respect to relative price $P_n$

$\xi_{2n} = \frac{a X_2}{a P_n X_2} P_n$: the supply elasticity of importables with respect to relative price $P_n$

$\xi_{2k} = \frac{a X_2}{a K_f X_2} K_f$: the output elasticity of importables with respect to capital
\[ m_j = p_j \left( \frac{aX_j}{a1} \right) : \text{the marginal propensity to consume goods} \]

Equation (3.32) reveals that the change of the quantity of import can be decomposed into three parts. The first term on the righthand side represents the substitution effect. Normally it has a positive coefficient, which means people will substitute import goods for non-traded goods if the relative price of the latter rises, and thus tends to increase imports. The term with \( \dot{K}_f \) shows the output effect. With inflow of capital, the output of importables expand and thus decreases the quantity of imports. The last term shows the income effect. Its contribution to import changes depends on whether the importable is a normal or an inferior good and whether the income increases or not.

Combining (3.26) - (3.28), (3.30) and (3.32), we can solve \( \ddot{I} \) as in equation (3.33).

\[
\ddot{I} = \frac{1 + \tau}{1 + \tau (m_1 + m_n)} \left\{ \begin{array}{l}
\left[ -\delta_1 \sigma_1 S_n \frac{\theta_{L1}}{\theta_{k1}} - \delta_2 \sigma_2 S_n \frac{\theta_{L2}}{\theta_{k2}} + \delta_n \sigma_n (1-S_n) \frac{\theta_{Ln}}{\theta_{kn}} \\
+ \delta_n + \delta_T \left[ e_{2n} + \frac{X_2}{M_2} (e_{2n} - \varepsilon_{2n}) \right] + \delta_2 \delta_f S_n \frac{\theta_{L2}}{\theta_{k2}} \right] \dot{P}_n \\
+ \left[ -\alpha \delta_1 S_1 \frac{\lambda_{L1}}{\lambda_{L1}} + \alpha \delta_2 (1-\theta_{L2} S_2) + \alpha \delta_n \theta_{Ln} S_n \frac{\lambda_{L2}}{\lambda_{Ln}} \right. \\
+ \alpha \delta_T \varepsilon_{2k} \frac{X_2}{M_2} - \delta_2 \delta_f + \alpha \delta_2 \delta_f S_2 \frac{\theta_{L2}}{\sigma_2} \right] \dot{K}_f \end{array} \right\} (3.33)
\]
The equilibrium condition of the non-traded goods market, equation (3.10), can be explicitly given as

$$D_n(P_n, I) = X_n(P_n).$$  \hspace{1cm} (3.34)

From (3.34), the relationship between $I$ and $P_n$ can be obtained.

$$\hat{I} = \frac{P_nX_n}{m_nI} \left( \hat{\xi}_{nn} + \xi_n + \xi_{nn} \right) \hat{P}_n$$  \hspace{1cm} (3.35)

where $\hat{\xi}_{nn} = -\frac{\partial D_n}{\partial P_n} \frac{P_n}{D_n} \mid_{du=0}$ is the compensated demand elasticity of non-traded goods.

$$\xi_{nn} = \frac{\partial X_n}{\partial P_n} \frac{P_n}{D_n},$$

the supply elasticity of non-traded goods.

Substituting (3.33) into (3.35), the change in the relative price of non-traded goods owing to the inward investment is determined.

$$\hat{P}_n = \frac{R}{Q} \hat{k}_f,$$  \hspace{1cm} (3.36)

where

$$R = \alpha s_2 \left( \frac{\alpha \lambda_2 \theta L_2}{\lambda} - \frac{\tau}{1+\tau} \xi_{2k} \right) \frac{(1+\tau)m_{n}}{1+\tau(m_n + m)}$$

$$Q = \frac{(1+\tau)m_{n}}{1+\tau(m_n + m)} \left[ \delta_1 \sigma_1 S_n \frac{\theta L_1}{k} + \delta_2 S_n (\sigma_2 - \delta_f) \frac{\theta L_2}{k} \right].$$
\[ \dot{s}_n(1 + \sigma_n(1 - S_n) \frac{\theta_{L_n}}{\theta_{k_n}}) - \dot{s}_T(e_{2n} + \frac{\chi_2}{M_2} (e_{2n} - \xi_{2n})) \]

\[ + \delta_n(\varepsilon_{nn} + m_n + \xi_{nn}) \]

Assuming that the system is stable, then \( Q \) is positive. Now, the impact on social welfare can be derived from (3.12) by making use of (3.13), (3.35), and (3.36).

\[ dU = U_1 dD_1 + U_2 dD_2 + U_n dD_n \]

\[ dy = \frac{dU}{U_1} = dD_1 + \frac{U_2}{U_1} dD_2 + \frac{U_n}{U_1} dD_n \]

\[ = dD_1 + P_2 dD_2 + P_n dD_n \]

\[ = dI - D_n dP_n \]

\[ = \frac{P_n \chi_n}{m_n} \left( \varepsilon_{nn} + m_n + \xi_{nn} \right) P_n - D_n P_n \]

\[ = \frac{P_n \chi_n}{m_n} (\varepsilon_{nn} + \xi_{nn}) P_n \]

\[ = \frac{P_n \chi_n}{Q} (\varepsilon_{nn} + \xi_{nn}) \alpha \delta_z \left( \frac{\alpha L_2 \theta L_2}{\Delta} - \frac{\tau}{1 + \tau} \xi_{2k} \right) \frac{1 + \tau}{1 + \tau (m_1 + m_n)} \]

(3.37)
Equation (3.37) shows how the direction of change in social welfare depends on both the consumption and production characteristics of all three sectors. If neither $x_1$ nor $x_n$ is so inferior as to make $1 + \tau (m_1 + m_n)$ negative, then we have

$$\frac{\alpha \lambda L_2}{\Delta} \frac{\alpha L_2}{\Delta} L_2 < \frac{\tau - \xi}{1 + \tau} 2k$$

(3.38)

since all the terms outside the parentheses of (3.37) are positive.

The higher the tariff rate and/or the output elasticity, $\xi_{2k}$, the more of $x_2$ will be produced with the increase of foreign capital. This means that more labor is allocated to the inefficient sector, reducing the country's imports and resulting in a smaller tariff income. Both of these outcomes are detrimental to the economy. The value of $\Delta$ represents basically the amount of foreign capital before the new inflow. It indicates the host country's gain from the decrease in the payments to the intramarginal units. When it is large, the host country can gain more from the additional foreign investment. The effect of $\lambda L_2$ is twofold. A large value of $\lambda L_2$, on the one hand, implies that less labor force can be reallocated to the importable sector from the other two sectors, which in turn implies less resource misallocation and less decrease in the tariff revenue. These are all to the advantage of the host country. On the other hand, $\lambda L_2$ can work through its effect on $\Delta$. We will detail this point when we discuss the effect of $\Delta$ below.

The importance of $\theta L_2$ can be most easily explained by referring to equation (3.17). Since $\theta L_2 + \theta k_2 = 1$, the higher the value of $\theta L_2$, the
lower is the value of $\theta_{k_2}$. Thus, for any given increase in the wage rate ($\dot{w} > 0$), equation (3.17) requires a large decrease in the rewards to the capital ($r^*_2 < 0$) in the importable sector when $\theta_{L_2}$ is large. This means that the payments to the intramarginal units of foreign capital decrease more when $\theta_{L_2}$ is relatively large than when it is small, which is, of course, good for the capital-receiving country. Finally, $\Delta$ will be small if the elasticity of marginal product curve of labor is small in each sector. A small elasticity of the marginal product curve of labor means that a change in the marginal productivity in one sector will not cause any significant change in the labor used in that sector. Thus, a small $\Delta$ in general implies that a rise in the marginal product of labor in the importable sector after the inflow of foreign capital does not attract a large amount of labor out of the other two sectors. The misallocation of labor can then be prevented by a small $\Delta$. Thus, the smaller $\Delta$ is, the better it is for the receiving country. Moreover, since $\Delta$ is a weighted average of the elasticities of the labor demand curves in all three sectors, the relevant weight and its corresponding elasticity make a crucial difference. For instance, suppose that the demand elasticities for labor are 0.5, 1.5, and 0.7 in sector 1, 2 and n, respectively. When the weights are $\lambda_{L1} = 0.2$, $\lambda_{L2} = 0.7$, and $\lambda_{Ln} = 0.1$, we have $\Delta = 1.22$; however, $\Delta = 0.57$ when we have $\lambda_{L1} = 0.7$, $\lambda_{L2} = 0.1$, and $\lambda_{Ln} = 0.2$ and $\Delta = 0.84$ when $\lambda_{L1} = 0.2$, $\lambda_{L2} = 0.1$ and $\lambda_{Ln} = 0.7$. This fact has important policy implications for the developing countries in their efforts to develop through foreign investment.
It is clear from (3.37) that the non-traded goods sector—not only its amount (or share) but also its characteristics of consumption and production—contributes to the final result concerning the welfare change. In addition to the possibility that a negative value of \(1 + \tau(m_1 + m_2)\) will reverse the conclusion based on (3.38), the more interesting point is its effect on the value of \(x\), as revealed in our numerical example. Equation (3.37) also implies that a country with larger \(I\), \(x_1\), and \(x_2\) will have a greater variation in its welfare during its effort to attract foreign capital for the production of importables.

D. Summary and Comparison

In this chapter we investigated the welfare effect of investment from abroad by taking into consideration two widely observed phenomena—the tendency for foreign investment to be concentrated in a limited number of industries and the importance of non-traded goods sector in developing countries. Owing to its generality, the model revealed some results which had not been obtained in the existing literature. The key results of our model can now be summarized and compared with those of other studies.

(1) As reviewed in Chapter II, most general equilibrium studies arrive at the conclusion that a small increase in foreign investment will immiserize the host country if it goes to the capital intensive tariff-protected sector (Hamada, 1974; Minabe, 1974; Brecher and Diaz Alejandro, 1977; Bhagwati, 1979; and Brecher and Findlay, 1983). We can compare and contrast our result with this result by making use of the diagram employed by Brecher and Diaz Alejandro.
In Figure 1, F denotes the free trade welfare level. T is the welfare level when a tariff is imposed without any foreign capital inflow. Brecher and Diaz Alejandro show that the inflow of capital will initially diminish the welfare of the host country, from T to A. Only when the amount is large enough to extinguish the receiving country's imports (point A) will the welfare start rising due to the Stolper-Samuelson effect, from A to M, the free trade welfare level. If the inflow continues to such a degree that the receiving country achieves complete specialization in capital-intensive imported goods, then its welfare rises again as shown by MacDougall (M'D). The result (3.38) differs from their conclusion in only one respect. Assume OA' corresponding to A is the amount of foreign capital needed to cease import. Then (3.38) implies that, depending on the values of Δ, α, λ2, θL2, τ and ξ2k, the country may move to M through any point on the vertical line A'A". TAM, TT'M and TT"M are three among them. In other words, even a small inward investment does not necessarily hurt the host country.

In his 1983 paper Srinivasan also obtained similar results as are obtained here. However, he stopped short at pointing out that the final welfare effect of foreign investment (into the tariff-protected importable sector) is ambiguous; nothing about the factors determining the direction of welfare change has been explicitly derived. Because of this shortcoming, his analysis is unsatisfactory for deriving possible policy implications for developing countries or for conducting empirical studies. In this respect, our analysis constitutes a significant improvement over Srinivasan's.
Figure 1. The Impact of Foreign Capital Inflow on the Host Country's Welfare
(2) Immiserizing investment from abroad is impossible when a small country follows the free trade policy (i.e., τ=0). This is quite clear from equation (3.38). When τ=0, the right-hand side of (3.38) is zero, but all the quantities in the left-hand side are positive. Thus, we always have an improvement of welfare after capital inflow. This is exactly the same result as reported by Burgess (1978) and Srinivasan (1983). It can also be shown that if the inward investment is in the exportable sector, it does not matter whether there is a tariff or not; the impact on welfare will be positive, a result again similar to those obtained by Minabe (1974), Brecher and Diaz Alejandro (1977) and Srinivasan (1983).

(3) The contradictory results obtained by the H-O-S general equilibrium analysis and the MacDougall-type partial equilibrium analysis can be readily reconciled by the results obtained in our model. It can be shown that each is only a special case of our model. In the partial equilibrium model, we cannot say anything about tariff, since there is only one product, and thus τ=0 in equation (3.38). The relevant terms in the left-hand side of (3.38) stay positive; therefore, the host country always benefits from inward investment, which is the conclusion obtained by MacDougall. On the other hand, under the H-O-S assumptions, as long as the host country remains incompletely specialized, the rewards to labor and capital will not be affected by foreign investment according to the factor-price equalization theorem. The marginal product curves are horizontal and hence have infinite elasticities. This means that Δ=0 in the general equilibrium analysis. The
left-hand side of equation (3.38) will reduce to zero in this case, which is, of course, less than any positive value on the right-hand side. This is why the H-O-S model always predicts negative effects from foreign investment in the tariff-protected capital-intensive importable sector. Our result points out that both of these two models consider only an aspect of the complex phenomenon of foreign investment. We have to look at the entire picture, as we have attempted to do, if we are to get a more satisfactory explanation of the impact of foreign investment on the host country.
NOTES

1In a model with a composite traded goods sector and a non-traded goods sector, Srinivasan (1983) demonstrates that inward investment into the non-traded goods sector is welfare-improving. This is, however, not our main concern here. Our interest is the welfare impact of inward investment into the tariff-protected importing sector when there exists a non-traded goods sector.

2This kind of sector-specific model is introduced by Jones (1971) and used later by Caves (1971), Burgess (1978), Das (1981), Brecher and Findlay (1983), Hamilton and Svensson (1983), Jones and Dei (1983), and Srinivasan (1983).

3A good summary of these policies can be found in Fry (1983), especially in Chapter 7 and Appendix I.

4Srinivasan's model stated in note 1 also assumes that there are no tariff or non-tariff barriers to trade so that a composite traded goods can be formed.

5When the inward investment goes to the exportable sector, we have

\[ dy' = \frac{P_n X_n}{Q'} \left( \bar{e}_{nn} + \xi_{nn} \right) \alpha \delta_1 \beta_1 \beta_1 \frac{1}{\Delta} \frac{1+\tau}{1+\tau(m_1 + m_n)} K_f \]

where

\[ Q' = \frac{(1+\tau)m_n}{1+\tau(m_1 + m_n)} \left[ \delta_1 S_n \left( \sigma_1 - \alpha \delta_k \right) \frac{\beta_1 \beta_1}{\beta_k} + \delta_2 \sigma_2 S_n \frac{\beta_2}{\beta_k} \right] \]

\[ \delta_n = \delta_n (1 + \sigma_n (1-S_n)) \frac{\alpha}{\beta_k} - \delta_r \left( e_{2n} + \frac{X_2}{M_2} (e_{2n} - \xi_{2n}) \right) \]

\[ + \delta_n \left( \bar{e}_{nn} + m_n + \xi_{nn} \right) \]

\( Q' \) is positive if the system is stable.
Chapter IV
WELFARE DYNAMICS IN THE PRESENCE OF FOREIGN DIRECT INVESTMENT AND TECHNOLOGY TRANSFER

A. Introduction

The impact of foreign investment on the host country's welfare was dealt with in some detail in the previous chapter. Instead of being either definitely detrimental or always beneficial, the final result depends on the production and consumption characteristics of all the commodities being considered. However, the model used is static, which is, no doubt, a serious drawback in analyzing the effect of foreign investment. In the first place, both investment and development are, by nature, dynamic phenomena. One of the main purposes of the developing country's deliberate effort to attract foreign investment is to obtain advanced technologies embodied in foreign investment activities. As innovation, diffusion, and emulation all take time, a dynamic model would be more adequate for studying these phenomena. Second, the factor endowments are also held fixed in the static analysis. Even the once-and-for-all increase in foreign capital is exogenously given. But over time, almost every aspect of the economy evolves. Population (and, hence, the labor force) grows; the level of capital stock changes, depending on the consumption and savings decisions of the whole economy as
well as the individual firms. Foreign investment activities may well be influenced by the policies adopted and the overall economic performance in the receiving country. Thus the relevant concept of comparative advantage should be a dynamic one when we are concerned about foreign investment strategies and development processes of developing countries. Third, intermediate to long-run economic planning has been such a vital concern for the developing world since the 1950s that any theoretical analysis would not be very meaningful unless it can provide some policy implications. The static model, because of its lack of consideration of the changing structure of the economy, will not be very useful in the formulation of detailed planning.

As reviewed in Chapter II, some efforts to incorporate the dynamics of foreign investment have been made in the past two decades. Nevertheless, there are at least two defects in the existing dynamic models. On the one hand, much of the literature in this area has assumed that saving is an arbitrary fixed proportion of national income (e.g., Negishi, 1965; Koizumi and Kopecky, 1977; Ruffin, 1979), while it may well be the product of an intertemporal optimization process of an entire economy. On the other hand, most treatments of the dynamic open economy model with foreign investment do not incorporate technology transfer, which is often cited as one of the most important merits of foreign direct investment. Koizumi and Kopecky (1977), Findlay (1978) and Gehrels (1983) are among the few exceptions. However, the first two do not study the problem in the context of optimal growth. Gehrels' discussion of optimal policies about foreign investment and technology
transfer fails to examine the steady-state properties of the economy. Therefore, the incorporation of an endogenous mechanism of technology transfer into an open economy growth model is the key concern of our research in this chapter.

Although the merits of technology transfer through inward investment are emphasized by many developing countries and development economists, there is no lack of criticism concerning the undesirable consequences of foreign investment such as loss of sovereignty, unequal capital ownership and income distribution, inappropriate technology, cultural conflict, and negative psychological impact.¹ Consideration of these undesirable consequences of foreign investment will also be dealt with in this chapter.

B. The Model

We study the problem of optimum capital accumulation and foreign investment for a small open economy. The only commodity, which is used for both consumption and accumulation, is produced by two factors of production, capital and labor. Since only one commodity is produced, there is no international trade. The model departs from the standard one by explicitly introducing a neutral technology transfer function to capture one of the most salient features of direct foreign investment.

Specifically, our economy is characterized by an aggregate production function, a technology transfer function, a community utility function, a supply function of foreign capital, and resource limits. (All the variables are in real terms and have time subscripts, which are omitted to simplify our notation.)
Let the growth rate of the labor force be $\lambda$. At any moment in time the economy's labor force equals

$$L = L_0 e^{\lambda t} \quad (4.1)$$

where $L_0$ is the labor force at the initial point.

If we use lower case letters to indicate per capita quantities, the relationship between per capita output and capital per worker, according to Koizumi and Kopecky (1977), is given by

$$x = \phi(k_f)f(k) = \phi(k_f)f(k_d + k_f) \quad (4.2)$$

where $k = k_d + k_f$ is the per capita capital stock used by the host country. The factor $k_d$ is the part domestically owned and $k_f$, which belongs to foreigners, is assumed to be non-negative, since we are interested in the developing countries. The sub-production function $f(k)$ is a well-behaved neoclassical production function satisfying the Inada conditions; namely,

$$f(0) = f'(\infty) = 0,$$

$$f(\infty) = f'(0) = \infty,$$

$$f'(k) > 0, \ k > 0,$$
\( f''(k) < 0, \ k > 0. \quad (4.3) \)

The specifications about \( k_f \) and the technology transfer function need some explanation. In a physical sense, foreign capital and domestic capital are homogeneous so that they can be added. Nevertheless, foreign investment also brings with it new technical know-how, entrepreneurship and management skills. Through the "contagion effect" such as discussion and training, these new and presumably superior ideas then permeate throughout the economy, and thus contribute to the improvement of domestic productivity (Caves, 1971; Koizumi and Kopecky, 1977; Findlay, 1978; Chen, 1983a). This process is reflected in the technology transfer function, \( \phi \), which is neutral with respect to the two factors of production. The function \( \phi \) depends on per capita (or per worker) foreign capital. It is assumed that a host country always experiences technology improvement from its contact with foreigners so that \( \phi(k_f) \) exceeds unity for any positive \( k_f \). Despite this positive effect, however, we assume that diminishing returns apply to such investment. Formally, we have

\[
\phi(k_f) \geq 1 \quad \text{according as } k_f \geq 0 \quad (4.4)
\]

\[
\frac{d\phi}{dk_f} = \phi'(k_f) > 0, \ \phi'(k_f) < \infty, \quad k_f \geq 0 \quad (4.5)
\]

\[
\frac{d^2\phi}{dk_f^2} = \phi''(k_f) < 0, \quad k_f > 0 \quad (4.6)
\]
\[
\frac{a^2 x}{3k_f^2} = \phi''(k_f)f(k) + 2\phi'(k_f)f'(k) + \phi(k_f)f''(k) < 0, \quad k_f > 0
\] (4.7)

We now turn to the supply side of foreign capital. Most of the developing countries are relatively small in the international capital market. In 1980, for instance, the flow of direct foreign investment into the developing countries was 7.654 billion, while that into the developed countries was 27.495 billion. Furthermore, the number of developing countries is far more than that of the developed countries. It is, therefore, quite reasonable to treat a single developing country as a small country. However, as pointed out by Hanson (1974) and Eaton and Gersovitz (1981), international investors cannot ignore the risks of national default and expropriation. These risks may be much more serious in the developing countries. The vulnerable economic capacity, the xenophobia inherited from colonial eras, and the highly uneasy political climate in the Third World all contribute to the potential risks of international investment. Thus, with more and more capital at stake, the investors will naturally ask higher and higher rewards to compensate for the risks they assume, which can be captured by an upward sloping supply curve of foreign capital. Symbolically, the supply function of foreign capital, \( S(k_f) \), can be defined as (4.8).

\[
S(k_f) > 0, \quad S'(k_f) > 0, \quad k_f > 0
\]

\[
S'(k_f) \rightarrow \infty \text{ as } k_f \rightarrow \tilde{k_f}
\]
\[ S'(k_f) > 0, \quad k_f > 0 \quad (4.8) \]

where \( \bar{k}_f \) is a constant, denoting the maximum amount of per capita foreign capital a developing country can obtain. A typical form for \( S(k_f) \) is shown in Figure 2.

Per capita national income, \( y \), is given by (4.9).

\[ y = x - k_f S(k_f) \quad (4.9) \]

According to the national income identity, we have

\[ y = c + i \quad (4.10) \]

where \( c \) is per capita consumption and \( i \), per capita gross investment. By combining (4.2), (4.9) and (4.10) and ignoring capital depreciation, we obtain the fundamental differential equation for this model:

\[ \dot{k}_d = \phi(k_f)f(k) - c - k_f S(k_f) - \lambda k_d \quad (4.11) \]

Assume that at any moment in time the community utility function depends on per capita consumption, thus abstracting away from the distributional problem. It is an increasing concave function as follows:
Figure 2. Foreign Capital Supply Function
\[ U = U(c) \]

\[ U'(c) > 0, \quad U''(c) < 0, \quad c > 0 \quad (4.12) \]

\[ \lim_{c \to 0} U'(c) = \infty, \quad \lim_{c \to \infty} U'(c) = 0 \]

The objective for the social planner is to maximize the discounted sum of the future utilities. So the problem can be formulated as

\[
\begin{align*}
\text{Max} \quad W & = \int_0^\infty U(c)e^{-\rho t}dt \\
\{c, k_f\} & \quad \text{subject to} \\
\dot{k}_d & = \phi(k_f)f(k_d + k_f) - c - k_fS(k_f) - \lambda k_d \\
k_{do} & = \overline{k}_{do} \\
k_f & \geq 0
\end{align*}
\]

\[ (4.13) \]

where \( \rho > 0 \) is the social rate of discount and \( \overline{k}_{do} \) is the given initial value of \( k_d \).

The optimization problem stated above is readily formulated as an optimal control problem. This is particularly appropriate since we are concerned about the development strategies in a developing host
country. Governments play crucial roles in almost all the developing countries today, although they are quite diverse in the degree of centralization. Most governments control to some extent macro as well as micro aspects of the economy such as savings (or consumption) and production decisions, not to mention trade and foreign investment policies. Moreover, as it will be shown later, the impact of foreign capital can be treated as a kind of externality. The conventional wisdom in economic theory in such a case is that government intervention is needed to achieve social optimality.

C. The Method and the Results

Define q as the costate variable associated with domestic capital accumulation. Then the current value Hamiltonian is

$$H(c, k_f; k_d, q)$$

$$= U(c) + q\left[\phi(k_f) f(k_d + k_f) - c - k_f S(k_f) - \lambda k_d\right]$$

(4.14)

By the Pontryagin maximum principle, we get the following conditions for optimization:

$$\frac{\partial H}{\partial c} = U'(c) - q = 0$$

(4.15)

$$\frac{\partial H}{\partial k_f} = q[\phi'(k_f) f(k) + \phi(k_f) f'(k) - S(k_f) - k_f S'(k_f)] < 0$$
according as \( k_f \geq 0 \) \hspace{1cm} (4.16)

\[
\dot{k}_d = \phi(k_f)f(k) - c - k_f S(k_f) - \lambda k_d
\] \hspace{1cm} (4.17)

\[
\dot{q} = pq - \frac{\partial H}{\partial k_d}
\]

= \(- q[\phi(k_f)\dot{f}(k) - (\lambda + \rho)]\) \hspace{1cm} (4.18)

Given these necessary conditions and the fact that the Hamiltonian, \( H(c, k_f; k_d, q) \), is concave in \((c, k_f, k_d)\), the transversality condition sufficient for optimality is\(^7\)

\[
\lim_{t \to \infty} e^{-pt} q > 0, \lim_{t \to \infty} e^{-pt} qk_d = 0
\] \hspace{1cm} (4.19)

Similar to Bardhan (1967), we will discuss the implications of these equations for three possible types of initial conditions: (1) \( \lambda + \rho > S(0) \); (2) \( \lambda + \rho = S(0) \); (3) \( \lambda + \rho < S(0) \).

Case (1): \( \lambda + \rho > S(0) \)

For this case, in order to investigate the steady state properties of the solution, we have to characterize the \( k_d = 0 \) and \( \dot{q} = 0 \) curves. By setting \( \dot{q} = 0 \) in (4.18), we get

\[
\phi(k_f)f'(k) = \lambda + \rho
\] \hspace{1cm} (4.20)
since \( q = U'(c) > 0 \) by (4.15) and (4.12). Under our assumption that \( \Phi \geq 1 \), equation (4.20) implies that with technology transfer, the capital intensity in the steady state will be higher than that corresponding to the usual golden rule.

If \( k_f = 0 \), then, from (4.16), it must be the case that

\[
f'(k_d) - S(0) < -\nu'(0)\phi(k_d) < 0 \tag{4.21}
\]

The assumption that \( \phi(0) = 1 \) was used in obtaining (4.21). From (4.20) and the initial condition, it follows that (when \( k_f = 0 \))

\[
f'(k_d) = \lambda + \rho > S(0)
\]

and so

\[
f'(k_d) - S(0) > 0 \tag{4.22}
\]

But (4.21) and (4.22) cannot hold at the same time. Thus the curve \( \dot{q} = 0 \) cannot be in the region where \( k_f = 0 \).

If \( k_f > 0 \), then (4.16) implies that

\[
\phi'(k_f)f(k) + \phi(k_f)f'(k) = S(k_f) + k_fS'(k_f) \tag{4.23}
\]

which means that the marginal social benefit and marginal social cost of foreign capital should be equalized for optimality. Rearranging (4.23), we obtain
\[
f' - (S+k_fS') = \frac{(1-\phi)(S+k_fS') - \phi'f}{\phi} < 0 \tag{4.24}
\]

It is interesting to compare (4.23) and (4.24). While the maximization condition requires equalization of marginal social benefit and marginal social cost, private profits will be negative under this condition. An immediate implication is that foreign investment will fall short of optimal quantity if all the foreign investment activities are left to private decisions.

Taking the partial derivative of \(\partial H/\partial k_f\) with respect to \(k_f\), we have

\[
\frac{\partial^2 H}{\partial k_f^2} = q \left[ \phi''(k_f)f(k) + 2\phi'(k_f)f'(k) + \phi(k_f)f''(k) 
- 2S'(k_f) - k_fS''(k_f) \right] < 0 \tag{4.25}
\]

by assumptions (4.7) and (4.8). Therefore, \(\partial H/\partial k_f\) is strictly monotonic along an optimal path. When \(k_f > 0\), (4.16) implicitly gives \(k_f\) as a function of \(k_d\) and \(q\). Totally differentiating (4.23), we get

\[
\frac{\partial k_f}{\partial k_d} = - \frac{\phi'(k_f)f'(k) + \phi(k_f)f''(k)}{\phi''(k_f)f(k) + 2\phi'(k_f)f'(k) + \phi(k_f)f''(k) - 2S'(k_f) - k_fS''(k_f)} \tag{4.26}
\]

\[
\frac{\partial k_f}{\partial q} = 0 \tag{4.27}
\]
Now, from equation (4.17), it can be shown that

\[
\frac{\ddot{a}_k}{\dot{a}_k} = (\phi'(k) f'(k) - \lambda) + (\phi'(k_f) f(k) + \phi'(k_f) f'(k) - C(k_f) - k_f S'(k_f)) \frac{\ddot{a}_k}{\dot{a}_k} \\
= (\phi'(k_f) f'(k) - \lambda)
\]  

(4.28)

because of \( k_f > 0 \) in (4.16). From (4.17) and (4.15), we obtain

\[
\frac{\ddot{a}_k}{\dot{a}_q} = -\frac{1}{U''(c)}
\]  

(4.29)

The slope of the \( \dot{k}_d = 0 \) curve is, by (4.28) and (4.29)

\[
\frac{dq}{dk_d} \bigg|_{\dot{k}_d = 0} = -\frac{\ddot{a}_k}{\dot{a}_k} \frac{\ddot{a}_k}{\dot{a}_q} \\
= U''(c)(\phi'(k_f) f'(k) - \lambda)
\]  

(4.30)

The sign of \( dq/dk_d |_{\dot{k}_d=0} \) depends on the relative magnitude of \( \phi'(k_f) f'(k) \) and \( \lambda \). However, from (4.18), we know that \( \phi'(k_f) f(k) = \lambda + \rho \) when \( \dot{q} = 0 \). So (4.30) is negative at the intersection of the \( \dot{k}_d = 0 \) and \( \dot{q} = 0 \) curves, where we have the stationary solution \( q = q^* \) and \( k_d = k_d^* \). For \( k_d < k_d^* \), \( \phi'(k_f) f'(k) - \lambda > \rho \), hence \( dq/dk_d |_{\dot{k}_d = 0} < 0 \). For \( k_d > k_d^* \) there exists a \( k_d^{**} \) such that \( dq/dk_d |_{\dot{k}_d = 0} = 0 \) at \( k_d = k_d^{**} \) and \( dq/dk_d |_{\dot{k}_d = 0} > 0 \) when \( k_d > k_d^{**} \). Figure 3 depicts the \( \dot{q} = 0 \) and \( \dot{k}_d = 0 \).
Figure 3. Phase Diagram for the Case Where $\lambda + \rho > S(0)$
curves and the stationary solution \((k_d^*, q^*)\). Linearizing equations (4.17) and (4.18) around the steady state solution \((k_d^*, q^*)\), the characteristic roots can be solved as\(^8\)

\[
h_1, h_2 = \frac{\frac{\dot{a}k_d}{a_k d} \pm \sqrt{\left( \frac{\dot{a}k_d}{a_k d} \right)^2 + 4 \frac{\dot{a}k_d}{aq} \frac{\dot{a}q}{a_k d}}}{2}
\]

(4.31)

where all the partial derivatives are evaluated at \((k_d^*, q^*)\). Since \(\frac{\dot{a}k_d}{aq} \frac{\dot{a}q}{a_k d} > 0\), the characteristic roots are both real and opposite in their signs. The steady state solution is, therefore, a saddle point. The arrows in Figure 3 show the possible stable branch.\(^9\)

It can be concluded that on the optimum growth path domestically owned capital, \(k_d\), will increase steadily if \(\dot{k}_{do} < k_d^*\) and decrease steadily if \(\dot{k}_{do} > k_d^*\). The solutions for the control variables, \((c^*, k_f^*)\), can be obtained by (4.15) and (4.23). However, unless further assumptions concerning the technology transfer function are made, it is not clear whether \(k_f\) will increase or decrease during its convergence to the steady state solution, \(k_f^*\), since the sign of (4.26) is ambiguous. It depends on the elasticity of the technology transfer function as well as that of the marginal productivity curve of capital for the sub-production function, \(f(k)\), i.e.,

\[
\frac{\partial f}{\partial k_d} \geq 0 \text{ iff } \frac{\partial K_f}{\partial k_d} < 0
\]
\[
\xi_{\phi} = \frac{d\phi}{dk_f} \frac{k_f}{\phi} \xi - \frac{3f'}{ak_f} \frac{k_f}{f'} = \xi_f
\] (4.32)

More precisely, there are two opposite forces generated by the inward investment on the aggregate production function. The first is the improvement of technology in the host country, and the second is the decrease in the marginal productivity of the sub-production function. The relative strength of these two forces will determine whether the host country should encourage more foreign investment in its path towards the steady state.

Case (2): \( \lambda + \rho = S(0) \)

In this case, again it can be proved that \( \dot{q} = 0 \) cannot be in the region where \( k_f = 0 \). When \( k_f = 0 \), \( \dot{q} = 0 \) implies

\[
f'(k_d) = \lambda + \rho
\] (4.33)

Also, as discussed above, (4.21) still holds. Substituting (4.33) into (4.21), we have

\[
\lambda + \rho - S(0) < 0
\]

or

\[
\lambda + \rho < S(0)
\] (4.34)
This contradicts the initial condition. Therefore, \( \dot{q} = 0 \) cannot be in the region where \( k_f = 0 \). When \( k_f > 0 \), the discussion in Case (1) follows immediately.

Case (3): \( \lambda + \rho < S(0) \)

Under this situation, it is easy to show that \( \dot{q} = 0 \) can be in the region where \( k_f = 0 \). Inserting (4.33) into (4.21), the result is exactly the initial condition. On the other hand, if the derivative of the technology transfer function is large enough, it is also possible for \( \dot{q} = 0 \) to be in the region with \( k_f > 0 \). By (4.20) and (4.23), we obtain

\[
\Phi'(k_f)f(k) + (\lambda + \rho) = S(k_f) + k_fS'(k_f) > S(0)
\]

or

\[
\Phi'(k_f)f(k) + (\lambda + \rho) - S(0) > 0 \tag{4.35}
\]

Hence, if additional foreign capital inflow can effectively result in technology transfer (i.e., when \( \Phi'(k_f)f(k) \) is large enough), equation (4.35) will still hold even if the initial condition makes \( (\lambda + \rho) - S(0) \) negative. The details for the case that \( \dot{q} = 0 \) in the region where \( k_f > 0 \) are the same as those in Case (1).

We now turn to the discussion of the case with \( \dot{q} = 0 \) in the region where \( k_f = 0 \). Under this situation (4.17) and (4.18) reduce to (4.36) and (4.37).

\[
\dot{k}_d = f(k_d) - c - \lambda k_d \tag{4.36}
\]
\[ \dot{q} = - q[f'(k_d) - (\lambda + \rho)] \] (4.37)

The slope of the curve \( \dot{k}_d = 0 \) is

\[ \frac{dq}{dk_d} \bigg|_{k_d=0} = U''(c)(f'(k_d) - \lambda) \] (4.38)

By the assumptions about \( U \) and \( f \), as \( k_d \) increases \( \frac{dq}{dk_d} \bigg|_{\dot{k}_d=0} \) will start with a negative value, becomes zero at a point \( k_d^{**} \), and then turns positive as \( k_d \) exceeds \( k_d^{**} \). But its value will be negative at \( \dot{q} = 0 \), which implies that \( f'(k_d) = \lambda + \rho \) from (4.37). This is depicted in Figure 4. By a linearizing process similar to that shown in Case (1), it is also true that the steady state solution is a saddle point.

D. Alternative Views

Up to this point, we have concentrated on the merits of foreign investment. Specifically, we have interpreted the function \( \Phi(k_f) \) as a technology transfer function, and confined ourselves to the assumption that \( \Phi(k_f) \geq 1 \) and \( \Phi'(k_f) > 0 \).

However, one should not overlook all the criticisms surrounding the activities of foreign investment. We will therefore reexamine our model developed in Sections B and C to see how our conclusions must be modified when we take into account these possible undesirable impacts of
\[ \phi'(0)f'(k_d) + f'(\hat{k}_d) = S(0) \quad \dot{q} = 0 \]

\[ k_f > 0 \]

\[ k_d = 0 \]

\[ k_f = 0 \]

\[ k_d^* \]

\[ k_d^{**} \]

\[ q^* \]

\[ q \]

Figure 4. Phase Diagram for the Case Where \( x_p < S(0) \) and \( k_f = 0 \)
foreign investment. In order to do this, the function \(\phi(k_f)\) is renamed as the foreign capital impact function, with the properties specified in (4.6), (4.7) and (4.39).

\[
\phi(0) = 1, \\
\phi(k_f) > 0, \quad k_f > 0. \tag{4.39}
\]

According to this specification, the foreign capital impact function covers not only technological or pure economic impact, but also social impact of inward investment. Thus, one major difference between the technology transfer function and the foreign capital impact function is that the value of the latter is not necessarily greater than one because of possible immiserizing impacts such as inappropriate technology, psychological strain and cultural distortions.\textsuperscript{10} The other difference is that the function \(\phi\) does not always have a positive slope as before, which means that additional foreign capital inflow may have either a positive or negative contribution to the host country's welfare. The positive effect may come from foreign investors becoming more familiar with and therefore more capable of adapting to local situations, or the people in the host country, with more contact with foreign cultures, adjusting themselves better to the new international environment. On the other hand, it is quite possible that with the presence of more and more foreign capital, foreign enterprises become more damaging to the host country. For example, foreign enterprises may just displace
the indigenous production, inhibit the formation of the local entrepre-
neurial class, and thus spoil the host country's effort at industri-
alization (Grossman, 1984). Or, they may ally with a small group of
local elite and try to maintain the socio-political status quo, which
works against the interests of the majority of the population. It is
even possible that these foreign enterprises become embroiled directly
in political struggles in the host country, as witness ITT's involvement
in the overthrow of Chile's Allende regime.

It is now clear that our model subsumes some of the recent liter-
ature in the dynamic models of foreign investment. For instance, Hamada
(1969) and Pitchford (1970) can be considered as special cases of our
model with \( \phi = 1 \). Koizumi and Kopecky (1977) focus on the positive
aspect of the foreign capital impact function, namely, a technology
transfer function with \( \phi > 1 \) and \( \phi' > 0 \). As we will discuss below,
Bardhan's model (Bardhan, 1967) can be interpreted as a special case of
ours, i.e., \( \phi < 1 \) and \( \phi' < 0 \). This last result is particularly inter-
esting. We indicate in note 10 that it is better to distinguish between
the detrimental effects of foreign capital resulting from different
sources, and treat them separately. The similarity between Bardhan's
results and ours implies that our model is general enough to give us all
the fundamental results regardless of the sources of the impacts.

The most devastating consequence of our new assumptions about \( \phi \) is
that they may invalidate the concavity property of the Hamiltonian \( H(c,
k_f; k_d, q) \). It is clear from (4.N1) of note 6 that this sufficient
condition for optimal solution may fail when \( \phi \) is close to zero. If
that is the case, then nothing more can be pursued under our model specification. However, the aggregate production function, $\phi(k_f)f(k)$, will be close to zero if $\phi$ is close to zero. Although this is mathematically possible, it is not economically meaningful. Even the worst planner should notice that there is no role for inward investment under this situation. Moreover, since $S' \rightarrow \infty$ as $k_f \rightarrow k_f$ and both $f'$ and $\phi'$ are bounded, chances are still good for (4.11) to hold provided that $\phi$ is not sufficiently small. This is what we are going to assume in what follows.

By similar procedures as we applied in Section C, we can obtain the results presented in Table 3. It is clear that the key factor determining whether a country should maintain foreign capital in the steady state is the marginal contribution of foreign investment, i.e., $\phi'$. As long as the foreign capital impact function has positive slope, the steady state properties discussed in the preceding section hold. Nevertheless, whenever $\phi' < 0$, the positive value of $k_f^*$ can hold only under the initial condition $\lambda + \rho > S(0)$. Although the steady state properties with $\phi' < 0$ and $k_f^* > 0$ are basically the same as those discussed in Case (1), Section C, there are crucial differences. First, depending on the value of $\phi$ and $\phi'$, the sign of (4.24) may be positive, negative or uncertain. Therefore, the private decision-making may deviate from the optimal policy in either direction. In the special case with $\phi < 1$ and $\phi' < 0$, equation (4.24) is positive and thus private decision makers tend to overly attract foreign investment because of their failure to recognize the implicit social costs, a result similar
Table 3  Steady state properties of the host economy in the presence of foreign capital impact function

<table>
<thead>
<tr>
<th>$\phi'(k_f)$</th>
<th>&gt; 1</th>
<th>= 1</th>
<th>&lt; 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi''(k_f)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1: $k_f^* &gt; 0$</td>
<td>C1: $k_f^* &gt; 0$</td>
<td>C1: $k_f^* &gt; 0$</td>
<td></td>
</tr>
<tr>
<td>C2: $k_f &gt; 0$</td>
<td>C2: $k_f &gt; 0$</td>
<td>C2: $k_f &gt; 0$</td>
<td></td>
</tr>
<tr>
<td>C3: $k_f &gt; 0$</td>
<td>C3: $k_f &gt; 0$</td>
<td>C3: $k_f &gt; 0$</td>
<td></td>
</tr>
<tr>
<td>$&gt; 0$</td>
<td>PP &lt; 0</td>
<td>PP &lt; 0</td>
<td>PP ?</td>
</tr>
<tr>
<td>$a k_f / a k_d &gt; 0$</td>
<td>$a k_f / a k_d &gt; 0$</td>
<td>$a k_f / a k_d &gt; 0$</td>
<td></td>
</tr>
<tr>
<td>$k^* &gt; k_g$</td>
<td>$k^* = k_g$</td>
<td>$k^* &lt; k_g$</td>
<td></td>
</tr>
<tr>
<td>(Koizumi and Kopecky)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| C1: $k_f^* > 0$ | C1: $k_f^* > 0$ | C1: $k_f^* > 0$ |
| C3: $k_f^* = 0$ | C3: $k_f^* = 0$ | C3: $k_f^* = 0$ |
| $= 0$ | PP < 0 | PP = 0 | PP > 0 |
| $a k_f / a k_d < 0$ | $a k_f / a k_d < 0$ | $a k_f / a k_d < 0$ |
| $k^* > k_g$ | $k^* = k_g$ | $k^* < k_g$ |
| (Hamada and Pitchford) |     |     |     |

| C1: $k_f^* = 0$ | C1: $k_f^* = 0$ | C1: $k_f^* > 0$ |
| C2: $k_f^* = 0$ | C2: $k_f^* = 0$ | C2: $k_f^* = 0$ |
| C3: $k_f = 0$ | C3: $k_f = 0$ | C3: $k_f = 0$ |
| $< 0$ | PP > 0 | PP > 0 |
| $a k_f / a k_d < 0$ | $a k_f / a k_d < 0$ | $a k_f / a k_d < 0$ |
| $k^* > k_g$ | $k^* = k_g$ | $k^* < k_g$ |
| (Bardhan) |     |     |     |
Table 3 (continued)

**Explanation of Notations**

C1: the initial condition $\lambda + \rho > S(0)$

C2: the initial condition $\lambda + \rho = S(0)$

C3: the initial condition $\lambda + \rho < S(0)$

$k_f^*$: per capita foreign capital in the steady state

PP: private profit when marginal social profit is equal to marginal social cost

$k_g$: capital intensity corresponding to closed economy golden rule
to that obtained by Bardhan (1967). Second, when $\phi' < 0$, the value of $\frac{\partial k_f}{\partial k_d}$ as expressed in (4.26) will be always negative, which means that $k_f$ always increases (decreases) as $k_d$ decreases (increases) to its steady state value. Third, when $\phi < 1$, we have $(\lambda + \rho)/\phi > \lambda + \rho$. Hence, the steady state capital intensity with foreign capital and $\phi < 1$ is smaller than that corresponding to the closed economy golden rule.\textsuperscript{11}

E. **Conclusion and Comparison**

Considering the dynamic nature of investment and development, we have investigated the problem of foreign investment in a one-sector optimal growth model. The possible benefits of technology transfer through foreign investment have been incorporated in our model to study one of the most important merits of direct foreign investment and the rationale of some developing countries' efforts in attracting foreign investment. In the last section of our analysis, the technology transfer function was re-interpreted as the foreign capital impact function, which is more general in the sense that it captures not only positive effects of foreign investment but also possible negative effects. Under the assumption that our specifications satisfy all the sufficient conditions of optimality, some key results of our model can be summarized as follows.

1. The key element determining whether a country should maintain foreign capital in the long run is the marginal impact of additional foreign investment, i.e., the sign of $\phi'$. With the possibility of technology transfer through foreign investment, the host country should
in most cases retain some foreign capital in the long run steady state. More specifically, unless the sum of the social discount rate and the growth rate of the labor force is well below the interest rate $S(0)$ and/or the technology transfer rate is not large enough, the optimal policy for the host country will always involve a positive amount of foreign capital. This conclusion is directly in contrast to those obtained by Bardhan (1967), Pitchford (1970), and Hamada (1969) where the only time for the host country to have foreign capital in the steady state is when $\lambda + \rho > S(0)$. However, our result will be similar to theirs if the marginal impact of foreign investment is negative, though in our case we might have $k_f^* = 0$ if $\lambda + \rho$ is not sufficiently greater than $S(0)$ and/or $\phi'$ is sufficiently small.

(2) The time profile of the control variable $k_f$ is also determined by the sign of $\phi'$. If this marginal impact is negative, we found that, when $k_{do} < k_d^*$, $k_f$ will decrease steadily as $k_d$ approaches its steady state value and vice versa for $k_{do} > k_d^*$. This result is the same as that reported by Bardhan (1967) and Pitchford (1965). On the other hand, when foreign investment brings with it superior technology and contributes positively to the host country, the time profile of the control variable $k_f$ need not be a monotonic function of $k_d$. It depends on the elasticity of the technology transfer function and that of the marginal productivity curve of capital associated with the subproduction function, $f(k)$.

(3) The steady state capital intensity depends upon the value of $\phi$. With $\phi$ greater than unity, the debtor country obtains the benefit of
higher capital intensity made possible by the influx of foreign capital. This is the same as the finding of Koizumi and Kopecky (1977). However, if foreign investment brings only detrimental effects, i.e., \( \phi < 1 \), the steady state capital labor ratio should be lower than that corresponding to closed economy golden rule when the optimal policy is followed.

Moreover, it can be shown from (4.17) and (4.18) that, for given \( k_f > 0 \), the relevant positions for the \( \dot{k}_d = 0 \) and \( \dot{q} = 0 \) curves with technology transfer, without technology transfer and with negative impact are as those depicted in Figure 5. All the notations with superscript "o" in Figure 5 denote the variables without technology transfer while the notations with superscript "\(^{\prime}\)" represent the variables when there is negative impact of foreign investment. As expected, we have \( k_d^{*} < k_d^{*0} < k_d^{\prime} \) and \( q^{*} < q^{*0} < q^{*\prime} \). By the negative relationship between \( q \) and \( c \), we have \( c^{*\prime} < c^{*0} < c^{*} \). That is, in the steady state the per capita consumption is higher when there is technology transfer than when there is not. The per capita consumption is lowest when foreign investment has negative impact. This, in turn, implies that the host country's welfare will be the highest when there is technology transfer and the lowest when there is negative contribution through foreign investment.

(4) Depending on the values of \( \phi \) and \( \phi' \), private marginal profit may deviate from marginal social benefit in either direction. This implies that perfect competition in general cannot achieve a solution which is socially optimal. Some kind of intervening policy to attract
Figure 5. Comparison of the Results of Foreign Investment with and without Technology Transfer and Negative Impact
or deter foreign investment needs to be adopted by the host country to offset this difference. This is not a surprising conclusion. The influx of foreign capital may be thought of as creating some technological as well as psychic externalities which are captured explicitly by the foreign capital impact function. Thus the standard answer to an externality problem, government intervention, is readily obtained.
Notes

1 A succinct summary of the critical literature can be found in Biersteker (1978).

2 This specification, although it treats technology transfer as endogenous, is still somewhat ad hoc in that no resources are used directly in the process of technology transfer. Ideally, a technology transfer function can be derived from some kind of optimization behavior in either the home or the host country.

3 This is only a simplified assumption; we have witnessed the rise of foreign investment from developing countries since the late 1960s (Chen, 1983a).

4 See UNCTC (1983), Annex Table II.2.

5 This kind of supply curve was used by Hamada (1969), Bardhan (1967) and Pitchford (1970). A theoretical model which gives rise to an upward sloping supply curve of foreign capital when there are risks of default and bankruptcy is provided in Eaton and Gersovitz (1981).

6 In addition to the assumptions made on the community utility function (U), the sub-production function (f), the technology transfer function (φ), and the supply function of foreign capital (S), the concavity of the Hamiltonian in (k_d, k_f, c) requires that

$$\phi(\phi'' f - 2f'S' - k_f f'S') - (\phi' f')^2 > 0$$

(4.01)

This condition is not too difficult to be satisfied under our assumptions, in particular, the assumption that S' → 0 as k_f → k_f.

Parenthetically, the famous result in the growth theory that "only Harrod neutral technological progress is consistent with steady state which is economically meaningful" is not applicable in our case. In fact, the inconsistency of other kinds of technological progress occurs only when both the growth rate of labor force and saving rate are fixed (Burmeister and Dobell, 1970, p. 77). In the optimal growth model, as we have here, the savings rate (or the consumption) is a control variable and thus can hardly be treated as a constant.
The condition (4.19) is a sufficient condition for optimality, but it is not a necessary condition (Long and Voutsos, 1977).

Expanding (4.17) and (4.18) around the steady state \((k^*_d, q^*)\), we obtain

\[
\begin{align*}
\dot{k}_d &= \frac{\partial k_d}{\partial k_d} (k_d - k^*_d) + \frac{\partial k_d}{\partial q} (q - q^*) \quad (4.2) \\
\dot{q} &= \frac{\partial q}{\partial k_d} (k_d - k^*_d) + \frac{\partial q}{\partial q} (q - q^*) \quad (4.3)
\end{align*}
\]

This system has the corresponding characteristic equation

\[
\begin{vmatrix}
\frac{\partial k_d}{\partial k_d} - h & \frac{\partial k_d}{\partial q} \\
\frac{\partial q}{\partial k_d} & \frac{\partial q}{\partial q} - h
\end{vmatrix} = 0 \quad (4.4)
\]

When all the partial derivatives are evaluated at \((k^*_d, q^*)\), by (4.18), (4.28) and (4.29), we have

\[
\begin{align*}
\frac{\partial k_d}{\partial k_d} &= \phi(k^*_f)f'(k^*) - \lambda \quad (4.5) \\
\frac{\partial q}{\partial q} &= - \frac{1}{U''(c^*)} > 0 \quad (4.6) \\
\frac{\partial q}{\partial k_d} &= - q^* \phi(k^*_f)f''(k^*) > 0 \quad (4.7) \\
\frac{\partial k_d}{\partial q} &= - \phi(k^*_f)f'(k^*) + (\lambda + \rho) = 0 \quad (4.8)
\end{align*}
\]

Substituting (4.5) - (4.8) into (4.4) gives us
\[
\begin{align*}
 h^2 - \frac{\dot{\alpha}_d}{\alpha_d} h - \frac{\dot{\alpha}_d}{\alpha} \frac{\ddot{\alpha}}{\alpha_d} = 0
\end{align*}
\] (4.9)

The solutions of (4.9) are expressed as (4.31).

If we assume that the supply curve of foreign capital is perfectly elastic, i.e., \(S(k_f) = \gamma\), a constant, then the necessary condition (4.16) becomes

\[
\frac{\partial H}{\partial k_f} = q \left[ \phi'(k_f)f(k) + \phi(k_f)f'(k) - \gamma \right] < 0 \quad \text{iff} \quad k_f \geq 0.
\]

But from (4.18) we have

\[
\phi(k_f)f'(k) = \lambda + \rho
\]

if \(q = 0\). So

\[
\frac{\partial H}{\partial k_f} = q \left[ \phi'(k_f)f(k) + \lambda + \rho - \gamma \right] > 0
\]

if the initial condition is \(\lambda + \rho > \gamma\) or \(\lambda + \rho = \gamma\). The necessary condition for optimality is not satisfied. In fact, since \(\frac{\partial H}{\partial k_f} > 0\), the country should import as much as possible of foreign capital in the steady state. The result of the initial condition \(\lambda + \rho < \gamma\) is interesting. The country can either end up with no foreign capital or with foreign capital. However, as long as the latter case occurs, it is better for the country to import as much as possible of foreign capital.

This is a highly simplified assumption. Ideally, we would like to separate the detrimental effects of foreign investment in the production and technology aspect from those in the consumption, political, and cultural and psychological aspects. Our specification captures well the production and technology aspect of foreign investment. However, the other aspects may be more naturally captured by a community utility function in the form of the disutility of foreign investment, as was done by Bardhan (1967).

We don't go to all the details of Table 3 since they are almost self-evident after our discussion above in Section C.
Chapter V

WELFARE DYNAMICS IN THE PRESENCE OF FOREIGN DIRECT INVESTMENT AND TECHNOLOGY TRANSFER: A TWO-SECTOR MODEL

A. Introduction

The static and dynamic models developed in Chapters III and IV follow two quite distinct traditions in the literature on international trade in investigating the complicated phenomenon of foreign investment. On the one hand, the comparative static approach used extensively by international trade theorists focuses on the existence of comparative advantage, the problem of resource allocation and trade policies. As was pointed out in Chapter IV, static models are not appropriate for exploring important dynamic characteristics of foreign investment such as technology transfer and culture impact. The dynamic approach, on the other hand, expands on various closed economy growth models. Not only are most dynamic models not in the context of optimal growth, but they are also one-sector models which do not allow the treatment of either two-way trade or resource allocation problem. Clearly, there is a theoretical gap between these two popular approaches in the literature on foreign investment. It is, therefore, interesting and meaningful to develop a two-sector dynamic model with trade and foreign investment, which will to some degree fill this gap.
Developing such a model is also important to study some crucial empirical problems encountered in the foreign investment activities. The developing countries have been trying desperately to build up industrial capacity in the hope of attaining self-sustained growth. As demonstrated in the experience of the Newly Industrializing Countries (NICs), they have become increasingly aware that direct foreign investment could be efficient in bringing with it modern technologies and produce net gains if properly managed. This is why so many lucrative investment incentives have been offered by developing countries to attract investment from abroad. Moreover, a recent trend of the industrial policies in the developing countries has been to treat foreign investment policy as an integrated and coherent part of the overall economic development strategies. In fact, some countries have been placing a growing emphasis on planning for and promoting the inflow of desired foreign investment and technology transfer into specific priority sectors. Depending on the political and economic philosophy, resource constraints, stages of development and the level of industrial and technological capabilities, the designated priority sector may vary from country to country. Some countries such as the Ivory Coast, Korea and Taiwan emphasize the export-promoting sector in an attempt to obtain the necessary foreign exchange for upgrading their own industrial capacity; others lean toward the import-substituting strategy and focus on the heavy industries from the beginning. Examples of the second group include India, Brazil, and Colombia before the mid-1960s. A fundamental question involved in this kind of development strategy is whether a
developing country should import foreign capital (which is owned domestically) all the time, or whether it should retain some amount of foreign capital (which is owned by foreigners) in the long run, or neither.

Based on both the reality of foreign investment strategies we face today as well as the deficiencies in the theoretical literature, we develop in this chapter a dynamic two-sector model with trade and foreign investment. Hopefully, by this we can: (1) extend the popular static general equilibrium model to a dynamic context, in which the mechanism of technology transfer can be studied and intertemporal optimal policies can be discussed; (2) bring the one-sector dynamic model one step closer to the static model and the real world so that optimal trade policies can be analyzed in a more realistic setting; (3) fill the gap between the static and the dynamic approaches; (4) test the robustness of the results obtained in the one-sector model.

B. The Model

Let us consider a small developing country pursuing industrialization and self-sustained growth. The economy consists of two sectors, an investment goods sector, $X_1$, and a consumption goods sector, $X_2$. Owing to the backwardness of indigenous technology and the small scale of the investment goods sector at the outset of its development process, the country has to export part of its consumption goods in order to exchange for the desperately needed investment goods. Moreover, in an attempt to obtain advanced management and production technologies, foreign
investment is welcomed into the investment goods sector. However, foreign investment is not allowed in the consumption goods sector since the investment goods sector is the sole priority sector under the import-substituting strategy. Hence, the developing country under consideration is employing physically identical capital from three different sources. First, it comes from domestic production; secondly, it is imported but owned domestically; and thirdly, it comes from foreign direct investment, which by definition is owned by foreigners. Our purpose is to investigate whether this country should keep importing investment goods and/or retain a positive amount of foreign capital in the long run in the context of an intertemporal optimization model. As was explained in Chapter IV, an intertemporal optimization is quite appropriate for investigating these problems, not only because of strategies involved in formulating development policies but also because of externalities that accompany foreign direct investment.

Suppose that the only two factors used in the production of consumption goods and investment goods are capital and labor. Then we have the production functions expressed as follows. (As we had in Chapter IV, all lower case letters represent per capita quantities and time subscripts are omitted for simplicity.)

\[ x_1 = v\phi(k_f/v)f_1(k_0+k_f/v) \]
\[ = v\phi(k_f/v)f_1(k_1) \]
\[ x_2 = (1-v)f_2(k_2) \]
where

\( x_i \): per capita output of the \( i \)th sector \((i=1, 2)\).
\( v \): the share of the labor force used in the investment goods sector, i.e., the first sector.
\( k_i \): the capital labor ratio in the \( i \)th sector \((i=1, 2)\).
\( k_f \): the capital stock per head owned by foreigners.
\( k_d \): per capita capital stock owned domestically in the sector with foreign investment.
\( f_i \): neoclassical production function with properties specified in (4.3), \((i=1, 2)\).
\( \phi \): technology transfer function with properties specified in (4.4)-(4.7).

Let \( k \) be the per capita capital stock owned by the host country. Then the domestic capital accumulation equation is given by

\[
k = x_1 + z_1 - \lambda k
\]

(5.3)

where \( z_1 \) denotes per capita import of investment goods and \( \lambda \) is the sum of population growth rate and capital depreciation rate.

Assuming that capital and labor are fully employed at any moment of time, we have the resource constraint (5.4).

\[
v k_d + (1-v)k_2 = k
\]

(5.4)
If the country's balance of payments always sums to zero, then we have

\[ \dot{p}z_2 - \dot{z}_1 + i_f - k_f S(k_f) = 0 \]  \hspace{1cm} (5.5)

where \( \dot{p} \) is a given international price of the consumption goods in terms of the investment goods; \( S(k_f) \), with the properties specified in (4.8), is the average rate of return to foreign investment in terms of the investment goods; \( i_f \) denotes per capita new investment from abroad and \( z_2 \) is per capita consumption goods exported.

Finally, the accumulation equation for the foreign owned capital stock is given by (5.6).

\[ k_f = i_f - \lambda k_f \]  \hspace{1cm} (5.6)

Since we are mainly concerned about a developing country, we assume that this country neither invests abroad nor exports investment goods. Thus, we have

\[ i_f \geq 0 \]  \hspace{1cm} (5.7)

and

\[ z_1 \geq 0 \]  \hspace{1cm} (5.8)
Now the planning authority wants to choose the inflow of foreign capital, the import of capital goods as well as the division of capital and labor between the two sectors so as to maximize the community utility function as expressed in (5.9) subject to equations (5.1)-(5.8) and the initial conditions (5.10) and (5.11).

\[ w = \int_0^\infty U(x_2 - z_2)e^{-pt} dt \] \hspace{1cm} (5.9)
\[ k_0 = k_0 \] \hspace{1cm} (5.10)
\[ k_{f0} = k_{f0}, \] \hspace{1cm} (5.11)

where the properties of \( U \) are stated in (4.12) and \( p \) represents the social rate of discount.

C. Necessary Conditions and Properties of Optimal Path

The model specified above is a problem of optimal control. The current value Hamiltonian for this problem is

\[ H(v, k_2, z_1, i_f; k, k_f, q_d, q_f) \]
\[ = U [(1-v)f_2(k_2) - 1/\beta(z_1 - i_f + k_fS(k_f))] \]
\[ + q_d [v\phi(k_f/v)f_1(k_d + k_f/v) + z_1 - \lambda k] \]
\[ - q_f (i_f - \lambda k_f) \] \hspace{1cm} (5.12)

where \( q_d \) and \( q_f \) are the costate variables associated with \( k \) and \( k_f \), respectively. Since \( q_d \) represents the current value of the shadow price of domestic capital and \( q_f \) represents that of foreign owned capital, the
Hamiltonian $H$ can be interpreted as the present value of per capita national income in terms of utility. The negative contribution of foreign capital accumulation is due to the fact that return to foreign investment must eventually be paid back when calculating the per capita gross "national" income of the host country.

By applying Pontryagin's maximum principle and noting that $k_d = \frac{k - (1-v)k_2}{v}$, conditions for optimality are given by:

\[
\frac{\partial H}{\partial \phi} = -U'f_2 + q_dk_2\phi f_1' + q_d(\phi f_1 - \frac{k_f}{v}\phi f_1' - (k_d + k_f/v)\phi f_1') = 0 \quad (5.13)
\]

\[
\frac{\partial H}{\partial k_2} = (1-v)U'f_2 - q_d(1-v)\phi f_1' = 0 \quad (5.14)
\]

\[
\frac{\partial H}{\partial z_1} = -\frac{1}{\rho} U' + q_d \leq 0 \quad \text{according as } z_1 \geq 0 \quad (5.15)
\]

\[
\frac{\partial H}{\partial i_f} = \frac{1}{\rho} U' - q_f \leq 0 \quad \text{according as } i_f \leq 0 \quad (5.16)
\]

\[
\dot{k} = v\phi f_1 + z_1 - \lambda k \quad (5.17)
\]

\[
\dot{k_f} = i_f - \lambda k_f \quad (5.18)
\]

\[
\dot{q_d} = (\rho + \lambda - \phi f_1')q_d \quad (5.19)
\]

\[
\dot{q_f} = (\rho + \lambda)q_f - \frac{1}{\rho} U'(S + k_fS') + q_d(\phi f_1' + \phi f_1') \quad (5.20)
\]
Equations (5.13) and (5.14) give us

\[
\frac{U'}{q_d} = \frac{\phi f_1 - \frac{k_f}{v} (\phi' f_1 + \phi f_1') - k_d f_1'}{f_2 - k_2 f_2'} = \frac{\phi f_1'}{f_2'}
\]  

(5.21)

which implies that the ratio of the shadow prices of the consumption and capital goods is equalized to the marginal rate of transformation of these two goods, a familiar efficiency condition. From (5.21) we also know that

\[
\frac{f_2}{f_2'} - k_2 = \frac{\phi f_1 - \frac{k_f}{v} (\phi' f_1 + \phi f_1')}{\phi f_1'} - k_d
\]  

(5.22)

So, adjusted for the impact of foreign capital in the investment goods sector, the ratio of the marginal product of labor to that of domestically owned capital must be equal across the two sectors along the optimal path. However, from (5.15) we can obtain

\[
\frac{U'}{q_d} \geq \bar{p} \quad \text{according as } z_1 \geq 0
\]  

(5.23)

It means that the ratio of the shadow prices of the consumption and capital goods should be no less than the given marginal rate of transformation through foreign trade (or terms of trade under our small country assumption). This is easily understood by comparing the marginal cost and marginal contribution of importing investment goods.

Note that \(q_d\) represents the marginal contribution of any change in domestic capital stock. Hence, an increase in investment goods imported
by one unit will contribute to raising the community utility by \( q_d \). On the other hand, with \( i_f \) held constant, any increase in import has to be paid through an increase in export of the consumption goods. The decrease in community utility caused by the increase in export is the marginal cost of importing an extra unit of investment goods. Equation (5.23) therefore implies that as long as the real cost, reflected by the ratio of marginal cost to marginal contribution of importing investment goods, is higher than the cost indicated by the terms of trade, an optimal policy should not involve importing foreign investment goods.

Moreover, equations (5.13), (5.14), and (5.15) also imply that, unless the optimal policy involves some positive amount of capital import \( (z_1 > 0) \), the marginal products of both labor and domestically owned capital in the investment goods sector will be higher than those in the consumption goods sector, evaluated at the international price \( \bar{p} \). That is,

\[
\phi f'_1 \geq \bar{p} f'_2
\]  

(5.24)

and

\[
\phi f'_1 - \frac{k_f}{v} (\phi' f'_1 + \phi f'_1') - k_d \phi f'_1 \geq \bar{p} (f'_2 - k_2 f'_2),
\]  

(5.25)

where the strict inequality holds when \( z_1 = 0 \). It is important to point out that (5.24) and (5.25) will hold with equality if domestic relative price is used to evaluate the marginal products of capital and labor.
This is due to the fact that the investment goods become non-traded goods in this model when \( z_1 = 0 \). Hence, the domestic relative price is no longer fixed through the world market. It will adjust itself and thus cause resource reallocation to the extent that the marginal productivity of any factor evaluated at the domestic relative price is the same in all sectors.

The interpretation of (5.16) is similar to that of (5.15) in terms of comparing the marginal cost and marginal contribution of foreign investment. The marginal cost of an extra unit of foreign capital is \( q_f \), the shadow price that the host country has to "pay back" to foreign investors. The marginal contribution of foreign investment is the increase in community utility which results from the decrease in consumption goods exported. When the terms of trade are so high as to exceed the ratio of marginal contribution to marginal cost of foreign investment, it is not worthwhile for the host country to accept any more investment from abroad.

Finally, (5.19) gives us the fundamental equation of capital theory. That is, the sum of capital gain \((\dot{q}_d/q_d)\) and own rate of interest \((\phi f'_1)\) is equal to the sum of time preference, depreciation rate, and population growth rate. Equation (5.20) is the foreign capital counterpart of (5.19). The similarity between them is clearest when there is an interior solution \((z_1 > 0, i_f > 0)\). In that case, (5.20) can be written as (5.26).

\[
\frac{\dot{q}_f}{q_f} + [(S + k_f S') - (\phi' f'_1 + \phi f'_1)] = \rho + \lambda \tag{5.26}
\]
Thus, the only difference between (5.26) and (5.19) is the adjustment term \((\phi' f^1 + \phi f^j)\).

Given these necessary conditions, the transversality conditions sufficient for optimality are

\[
\lim_{t \to \infty} e^{-t} q_d \geq 0, \quad \lim_{t \to \infty} e^{-t} q_d k = 0 \tag{5.27}
\]

\[
\lim_{t \to \infty} e^{-t} q_f \geq 0, \quad \lim_{t \to \infty} e^{-t} q_f k_f = 0 \tag{5.28}
\]

D. **Foreign Capital Stock and Imports in the Steady State**

We now turn to the properties of a steady state equilibrium if one does exist. Our main interest is whether there is a positive amount of foreign capital and/or import in the long run when an optimal policy is followed.

Let us denote the steady state value of a variable or a function with an asterisk, "". Then, if \(k_f^* = 0\), from (5.18) we should have \(i_f^* = 0\) because \(\dot{k} = \dot{k}_f = \dot{q}_d = \dot{q}_f = 0\) in the steady state. By (5.16), we also have

\[
q_f^* > \frac{1}{\rho} U'^*
\tag{5.29}
\]

From equation (5.19) we know that if \(k_f^* = 0\), then

\[
f_1^* = \rho + \lambda \tag{5.30}
\]
since $\phi(0) = 1$. Combining (5.20), (5.29) and (5.30), we obtain

$$((\rho + \lambda) - S(0)) q_f^* < - q_d^* (\phi'(0)f_1^* + \rho + \lambda) < 0$$  \hspace{1cm} (5.31)

By the assumption that $U' > 0$, we get $q_d^* > 0$ and $q_f^* > 0$ from (5.14) and (5.16), respectively. This means that (5.31) cannot hold as long as the initial condition is $\rho + \lambda > S(0)$ or $\rho + \lambda = S(0)$. Of course, it may be satisfied when the initial condition is $\rho + \lambda < S(0)$. These conclusions are exactly the same as those obtained in the one-sector model.

By applying similar procedures and making use of (5.15), we can obtain equation (5.32) when $k_f^* > 0$, which is the two-sector counterpart of equation (4.35).

$$\phi'(k_f^*) f_1^* + (\rho + \lambda) + ((\rho + \lambda) - S(0)) > 0$$  \hspace{1cm} (5.32)

For the initial condition $\rho + \lambda > S(0)$ and $\rho + \lambda = S(0)$, the inequality in (5.32) is always satisfied. It is also clear that, when $\rho + \lambda < S(0)$, equation (5.32) can still hold so long as the difference between $\rho + \lambda$ and $S(0)$ is not too large and/or the technology transfer is strong enough. Again, the conclusions in the one-sector model are duplicated in the two-sector model.

It is interesting to note that the conclusions obtained above do not depend directly on the quantity of the imported investment goods. However, a moment of analysis clarifies the puzzle. From the host
country's point of view, there is no difference at all between the investment goods produced domestically and those imported from abroad. They are physically and functionally identical. Moreover, in order to import more investment goods, the host country has to export more consumption goods. This is economically the same as increasing the domestic production of investment goods, which requires the shift of resources out of the consumption goods sector. In both cases, the results are the same: an increase in domestically owned capital at the sacrifice of some consumption goods. The only effect that the import of investment goods has on the steady state foreign capital level is through its contribution to $k^*$, which in turn determines $f_1^*$ in (5.31) and (5.32). In this general model, therefore, we might end up with any of the following four situations: (1) $k_f^* = 0$, $z_1^* = 0$; (2) $k_f^* > 0$, $z_1^* = 0$; (3) $k_f^* = 0$, $z_1^* > 0$; (4) $k_f^* > 0$, $z_1^* > 0$.

It is desirable, however, to examine the elements affecting $z_1^*$, though the possible value of $z_1^*$ cannot be determined completely from the initial conditions. This can be done by comparing the steady state values of $q_d$ and $U' / \bar{p}$, i.e., $q_d^*$ and $U^* / \bar{p}$. When $q_d^* < U^* / \bar{p}$, it implies that $z_1^* = 0$; otherwise we have $z_1^* > 0$.

If $k_f^* = 0$, then $U^* / \bar{p} < q_f^*$, and from (5.31), we obtain

$$q_d^* / \frac{U^*}{\bar{p}} < \frac{S(0) - (\rho + \lambda)}{(\phi'(0)f_1 + \rho + \lambda)}$$

(5.33)
Since $k_f^* = 0$ holds only under the condition that $\rho + \lambda < S(0)$, the right hand side (RHS) of (5.33) is always positive. It is clear that $z_1^* = 0$ insofar as the value of the RHS of (5.33) is equal to or less than one. This means that, given the fact that the host country does not retain any foreign capital in the steady state, it will not import investment goods unless $S(0) - (\rho + \lambda)$ is large and/or the value of the potential technology transfer is quite negligible.

When $k_f^* > 0$, then $U^*/\tilde{p} = q_f^*$, and from (5.19) and (5.20), we have

$$
q_d^* / \tilde{p} = \frac{S^* + k_f^* S_{1r}^* - (\rho + \lambda)}{s^* f_1^* + \rho + \lambda}
$$

(5.34)

Again, whether the host country will import investment goods in the steady state depends on the value of the RHS of (5.34). If $\text{RHS} \geq 1$ in (5.34), then $z_1^* > 0$, while $z_1^* = 0$ when $\text{RHS} < 1$ in (5.34). Therefore, given that $k_f^* > 0$, the following conclusion is derived: the host country will import investment goods in the steady state when there are small values of $\rho + \lambda$, a large increase in the payment to foreign investment, accompanied by low value of technology transfer. Otherwise, the host country will have $z_1^* = 0$. There is one crucial difference between the determination of $k_f^*$ and $z_1^*$. While $k_f^*$ can be determined by the initial condition, $z_1^*$ is significantly affected by the shape of the foreign capital supply function and the technology transfer function. In general, the more elastic the foreign capital supply function and/or the more inelastic the technology transfer function, the higher the probability for the host developing country to import investment goods in the steady state.
Some relationships between our model and the existing literature are worth noting. As mentioned above, when $z_1^* = 0$ the investment goods become non-traded goods and the domestic relative price can no longer be fixed as we assumed. Thus, our model is not suitable for analyzing the case with $z_1^* = 0$. In fact, when $k_f^* = 0$ and $z_1^* = 0$, the model reduces to the familiar closed economy two-sector model. The case with $k_f^* > 0$ and $z_1^* = 0$ is similar to the model studied by Bazdarich (1978), though in a different context and for a different purpose. Bardhan (1970) discussed the dynamic optimal properties of a small open economy engaged in international trade. That corresponds precisely to the case with $k_f^* = 0$ and $z_1^* > 0$.

When the steady state is the one with $k_f^* > 0$ and $z_1^* > 0$, then we have an interior solution for our model. Theoretically, we can solve the steady state values of all the control, state and costate variables. Specifically, setting $\dot{q}_d = \dot{q}_f = 0$ and making use of the fact that $q_d = q_f$ from (5.15) and (5.16), we can determine $v^*$, $k_2^*$, $k^*$ and $k_f^*$ by solving equations (5.13), (5.14), (5.19) and (5.20). Setting $\dot{k} = \dot{k}_f = 0$ and substituting $v^*$, $k_2^*$, $k^*$, and $k_f^*$ into (5.17) and (5.18) give us $z_1^*$ and $i_f^*$. Finally, $q_d^*$ and $q_f^*$ can be solved from (5.15) and (5.16). As soon as these steady state values are obtained, we can perform comparative dynamic analysis to see the effects of changes in terms of trade, population growth rate or social discount rate.

Unfortunately, given the complexity of our model as revealed by the Hamiltonian as well as the four differential equations which are derived from it, it is impossible to characterize the optimal time paths of the
state and control variables. A complete solution and a phase diagram analysis require appropriate choice of the functional forms of the consumption function, the production functions, and the foreign capital supply function. We will not attempt this task in this thesis.

E. Summary and Conclusions

In this chapter one of the potential benefits of foreign investment, technology transfer, was incorporated into a two-sector growth model with international trade. The purpose of such an extension was twofold. On the one hand, it was hoped to bridge the theoretical gap between static and dynamic analyses. On the other hand, it was intended to bring the rather abstract one-sector growth model one step closer to the real world and to test the robustness of the results obtained in Chapter IV. Although no explicit solution can be obtained from this analysis owing to the generality and complexity of the model, there are interesting findings which might contribute to our understanding of the problems involved in foreign investment policies.

(1). The basic efficiency conditions in production, consumption, and international trade are not affected by the presence of foreign investment. But the concepts of marginal products of labor and capital in the investment goods sector have to be modified somewhat when there is technology transfer through foreign ownership. The existence of technology transfer also causes the major difficulty in the dynamic analysis if the policy adopted includes \( i_f > 0 \) and \( z_1 = 0 \). This is due to the fact that investment goods become non-traded goods in this
situation and thus the domestic relative price becomes endogenous. However, the one-to-one correspondence between the domestic relative price and the wage rental ratio, which is employed to solve the dynamic paths by most works such as Bazdarich (1978), is destroyed by the presence of foreign technology transfer function.  

(2). The most important conclusion of this chapter is that all the conclusions we obtained in Chapter IV still hold in the two-sector model with international trade. Namely, the host developing country should retain a certain amount of foreign capital in the long-run steady state ($k_f^* > 0$) when the initial condition is $\rho + \lambda > S(0)$ or $\rho + \lambda = S(0)$; even if the initial condition is $\rho + \lambda < S(0)$, it is still beneficial to the host country to have $k_f^* > 0$ as long as the difference between $S(0)$ and $\rho + \lambda$ is not too large and/or the benefit of technology transfer is strong enough. Furthermore, it is easy to show that the conclusions are the same when the host country's priority sector is the consumption goods sector; that is, the host country is adopting an export-promoting development policy. Based on our analysis, therefore, the general conclusion that, when the foreign investment brings with it advanced technologies, a host developing country should in most cases maintain a positive amount of foreign capital in the long run, is quite robust.

(3). The finding that the steady state value of foreign capital stock is independent of that of investment goods imported is somewhat surprising but makes sense upon closer examination. It is due to the fact that domestically produced and imported investment goods are indistinguishable either functionally or economically. It implies that,
without more explicit specification, the model may lead to any of of the following four situations: (1) \( k_f^* = 0, z_1^* = 0 \); (2) \( k_f^* > 0, z_1^* = 0 \); (3) \( k_f^* = 0, z_1^* > 0 \); (4) \( k_f^* > 0, z_1^* > 0 \). These possibilities enables us to compare our model with some of the existing literature. Moreover, checking the relevant steady state conditions reveals what factors are affecting the import of investment goods. Whenever \( \rho + \lambda \) is far below \( S(0) \), the host country should import investment goods in the steady state to enjoy the "gains from trade," though it is not worthwhile to accept investment from abroad. This conclusion is strengthened when the potential marginal contribution of foreign capital is small. If the steady state foreign capital stock is positive, then the host country should import investment goods provided that the technology transfer is not significant and/or the payments to foreign capital increase drastically.

(4). Although we do not repeat the exercise of the foreign capital impact function, it is not difficult to work out a similar exercise here as the one we performed in Chapter IV. In fact, the key results will be similar to those reported in Chapter IV. As in the one-sector model, the major impact of relaxing the assumption of the technology transfer function is on the validity of the sufficient condition for optimization. It can be shown that some interesting conditions such as \( k_2 > k_d + \frac{k_f}{V} \) and \( \phi f_1 f_1' > (\phi' f_1)^2 \) are found necessary for the sufficient condition to hold. The second one of these two conditions, of course, depends crucially on the value of \( \phi \). The capital intensity condition, \( k_2 > k_d + \frac{k_f}{V} \), is interesting in terms of linking the
dynamic model with the static model. Since there are essential
differences in the community utility function in the two models, direct
comparison between them is not possible. Nevertheless, the particular
requirement of capital intensity relationship does provide clues in
tracing out the process of resource allocation, which is the principal
cconcern of the static model, in the dynamic model of a growing economy.
NOTES

1See UNCTC (1983) and Goldsbourough (1985).

2The possibility of complete specialization in producing investment goods \((v = 1)\) or consumption goods \((v \neq 0)\) is not interesting in this model since the main concern here is the production property of foreign investment instead of the consumption purpose of foreign borrowing.

3The intricate question of existence of an optimal policy is neglected in our discussion, though it is rather critical in a system with an infinite time horizon (Pitchford, 1977). Let us quote from Bardhan (1970), "If an optimal policy exists, the necessary conditions for optimality are the same whether the horizon is finite or infinite."

4The key difference between our model, with \(i_f^* > 0\) and \(z_1^* = 0\), and Bazdarich's is the presence of the technology transfer function. As pointed out in the conclusions, this causes the major difficulties in analyzing the dynamic paths to the steady state.

5See the discussion of Pitchford (1977) about the difficulties of a two-state variables optimal control problem.

6No such problem will exist for any policy involving \(i_f = 0\), since \(\phi(k_f) = \phi(0) = 1\).

7The export-promoting model is represented by equations (5.1) – (5.11) except replacing (5.1), (5.2) and (5.4) by the following three equations.

\[
x_1 = \nu f_1(k_1)
\]

\[
x_2 = (1-\nu)\phi(k_f/(1-\nu))f_2(k_d+k_f/(1-\nu))
\]

\[
= (1-\nu)\phi(k_f/(1-\nu))f_2(k_2)
\]

\[
\nu k_1 + (1-\nu)k_d = k
\]
With some changes in the Hamiltonian, say $\tilde{H}$, we can get the following necessary conditions for optimization.

\[
\frac{\partial H}{\partial v} = q_d f_1' - U'k_1 f_2' - U'(f_2') - \frac{k_f}{1-v} f_2' - (k_d + \frac{k_f}{1-v}) f_2' = 0 \quad (5.13')
\]

\[
\frac{\partial H}{\partial k_1} = -U'v f_2' + q_d v f_1' = 0 \quad (5.14')
\]

\[
\frac{\partial H}{\partial z_1} = -\frac{1}{p} U' + q_d \leq 0 \quad \text{according as } z_1 \geq 0 \quad (5.15')
\]

\[
\frac{\partial H}{\partial i_f} = \frac{1}{p} U' - q_f \leq 0 \quad \text{according as } i_f \geq 0 \quad (5.16')
\]

\[
\dot{k} = v f_1' + z_1 - \lambda k \quad (5.17')
\]

\[
\dot{k}_f = i_f - \lambda k_f \quad (5.18')
\]

\[
\dot{q}_d = (\rho + \lambda)q_d - U'f_2' \quad (5.19')
\]

\[
\dot{q}_f = (\rho + \lambda)q_f + U'(f_2' + \phi f_2') - \frac{U'}{p} (S + k_f S') \quad (5.20')
\]

From the necessary conditions we can easily get the following relationships.

\[
f_1' = \rho + \lambda \quad (5.30')
\]

\[
((\rho + \lambda) - S(0)) q_f' < -U'(\phi'(0)f_2' + f_2'^*) < 0 \quad (5.31')
\]

\[
\bar{p} \phi'(k_f^*) f_2' + (\rho + \lambda) + ((\rho + \lambda) - S(0)) > 0 \quad (5.32')
\]
These have exactly the same implications as those of (5.30), (5.31) and (5.32). The interpretation in the text can, therefore, be followed immediately.

The sufficient condition for optimization is that the Hamiltonian is concave in \((v, k_2, z_1, i_f, k, k_f)\). This requires that all the principal minors of the relevant \(6 \times 6\) Hessian determinant alternate in sign such that all the odd-numbered principal minors are negative and all even-numbered ones are positive. To check the concave property of \(H\) is a very tedious and complicated task. The conditions reported are derived from the first three principal minors.
Chapter VI
CONCLUDING REMARKS

The purpose of this thesis was to investigate the potential impact of foreign investment on the host country's welfare. In this connection, we analyzed such questions as whether a developing country benefits from foreign investment and whether development strategies should include foreign participation in the long run. These problems were analyzed in both static and dynamic contexts, where some crucial characteristics of foreign investment in developing countries were incorporated.

In the static part, we extended Jones' sector-specific model to a three-sector model so that two widely observed phenomena in developing countries could be taken into consideration--the tendency for foreign investment to be concentrated in a limited number of industries and the importance of a non-traded goods sector. The precise conditions for determining the welfare effects of foreign investment were derived. Specifically, we showed that the consumption characteristics of all three commodities, the pattern of allocation of the labor force and the elasticity of demand for labor in each sector, the tariff rate as well as the proportion of foreign capital, the share of labor cost and the output elasticity of capital in the importable sector all contribute
to determining the direction of welfare impact due to the inflow of foreign capital.

This finding is particularly interesting and represents a significant improvement over the existing literature, for it clearly shows the mechanism by which foreign investment affects the host country's welfare. There is, of course, no a priori reason why investment from abroad should have either an unambiguously beneficial or deleterious impact. Our finding clearly indicates the parameters which policy makers need to take into consideration in formulating policies with respect to foreign investment. To our knowledge, this is the only theoretical model that provides such explicit and useful information in this area. Contrary to other theoretical studies, the results obtained in Chapter III can indeed be easily formulated as testable hypotheses to perform the badly needed empirical analyses. In fact, the empirical studies derived from our model would improve the existing empirical work, most of which are based on somewhat casual observations and lack appropriate theoretical foundations.

Another interesting finding from our model is that the contradictory results obtained by the Heckscher-Ohlin-Samuelson general equilibrium analysis and the MacDougall-type partial equilibrium analysis can be easily reconciled. Both of them turn out to be special cases of our general sector-specific model. The H-O-S model corresponds to the case where the elasticity of demand for labor is infinite, while the partial equilibrium model corresponds to the case where the tariff rate is zero.
In the dynamic part, we analyzed the optimal capital accumulation of a small open economy by taking into account another salient feature of foreign investment—technology transfer. Within the framework of a one-sector growth model, it was assumed that the transfer of technology depends on the extent of the foreign ownership of a country's capital stock. The marginal impact of additional foreign investment was found to be crucial in determining whether a developing country should maintain foreign capital in the long run by affecting the time profile of the inward investment. As long as there is technology transfer through foreign participation, it was found that the long run steady state foreign capital stock should in general be kept at a positive level. In the last part of the discussion of the one-sector model, we introduced the concept of a foreign capital impact function by relaxing the assumption of the technology transfer function. This way we were able to capture not only the positive effects of foreign investment but also possible negative effects. It was found that most of the existing literature in this area can be interpreted as special cases of our foreign capital impact function. Moreover, since the impact of foreign investment can be regarded as a kind of externality, government intervention was found to be necessary for either encouraging or restricting foreign capital inflow to achieve social optimality.

Our concept of the foreign capital impact function also clarifies the key difference between the modernization and the dependency theory in the development literature. The modernization theory asserts that the marginal impact of foreign capital is beneficial for the host
country because of the transfer of scarce capital and advanced technology from developed countries. In the context of our foreign capital impact function, their argument is the same as saying that the first derivative of the function is positive. Thus, even if the host country cannot enjoy static gains from improved allocation of resources, it will reap dynamic benefits from foreign investment. The assertion of the dependency theory, on the other hand, can be interpreted as implying the negatively sloped foreign capital impact function. In this case, any policy aimed at development through foreign investment will definitely backfire in the long run for the host country, though there might be some immediate benefits. Therefore, an important policy implication which emerges from our analysis is that the amount of foreign capital should not, in and of itself, be treated as a first priority item in formulating development policies. What is important for policy makers is to carefully choose the strategic sectors which have favorable production and consumption characteristics and to provide the mechanism by which the positive benefits of foreign capital can be efficiently developed and reaped.

The one-sector model was then extended to a two-sector growth model with international trade so that the static and dynamic analyses can be made more comparable and the robustness of the conclusions from the one-sector model can be tested. We found that all the results concerning the long-run steady state foreign capital level are the same as those derived in the one-sector model. Moreover, the steady state value of foreign capital stock is determined independently of that of capital
imported. The host country should import investment goods in the steady state whenever the initial payment to foreign investment is too high (for the case $k_F^* = 0$), the increase in payments to foreign investment is too fast (for the case $k_F^* > 0$) and/or the extent of technology transfer through foreign participation is limited. Owing to the complexity and generality of this model, we were unable to study the dynamic paths of the relevant variables in their original form. Hopefully, some way of simplification or specific forms of the functions in the model can be found so that a more complete and satisfactory solution can be obtained in the future.

Although our findings are interesting and can certainly be utilized in building a more complete theoretical model concerning the effects of foreign investment, we have to exercise some caution in applying them directly to a particular developing country. Our thesis is still deficient in several important areas. First, as we stressed at the very beginning, our study focuses only on the welfare effect of foreign investment from the host country's point of view. Since welfare is defined here to depend only on consumption or per capita consumption, it ignores completely other aspects of social welfare. Among the most well-documented of these other welfare effects is the impact of inward investment on the host country's income distribution. Another important index to evaluate the impact of foreign investment is its ability to create employment in the host developing country. Again, this is absent from our analysis because of the full employment assumption. Secondly, we have neglected many factors which may significantly alter the final
results concerning the effects of foreign investment, even though the
technology transfer function has taken care of more important ones. It
is widely recognized that the host country's financial, industrial, tax
and tariff policies have a strong influence on the costs and benefits
associated with foreign investment. Yet our simplified models could not
give us much information on these factors. Thirdly, one of the major
limitations of our study is that both our static and dynamic models are
specified under the small country assumption. Although useful in
serving as a first approximation to the reality of most developing
countries, the terms of trade effect needs to be incorporated into the
analysis of any long run development problem of an open economy.
Fourth, it is implicitly assumed in this thesis that all the markets are
perfectly competitive. However, as pointed out repeatedly in the recent
literature on the activities of multinational enterprise (MNE), one of
the most important factors for the emergence of MNEs is the existence of
imperfect markets. The MNEs engage in investing abroad simply because
they want to extract monopoly or oligopoly profits from their intangible
assets. Thus, neglecting this type of foreign investment activities is
another shortcoming of our models.

In view of these deficiencies, further study is needed to relax the
full employment and the small country assumptions and to specify an
explicit income distribution mechanism in the host developing country.
The complexity of a dynamic model with all of these factors incorporated
in it may hinder any reasonable theoretical investigation. However, in
order to understand more thoroughly the problems of foreign investment,
it is desirable to incorporate these factors, either separately or, if possible, jointly. Another potentially interesting extension of our study would be to allow some policy variables such as the tax rate so that comparative dynamics analysis can be performed. It is also worthwhile to analyze the uncertainty problem now implicitly reflected in an upward sloping foreign capital supply curve. In particular, an explicit behavior assumption of the host country with the uncertainty of foreign investment in the planner's mind might give us a more promising foreign capital impact function than the one used in Chapters IV and V. It is also important to introduce some kind of imperfect market structures into our models. This way we can see how the conclusions obtained here are affected under different market structures. Finally, although the deficiencies and simplifications of the dynamic models make it difficult to perform empirical analyses, it is still interesting and useful to see to what extent the results obtained here correspond with actual foreign investment activities. And some efforts need to be devoted to estimating the foreign capital impact function if we are to resolve the controversies between the modernization and the dependency school.
BIBLIOGRAPHY


