MODELLING THE MULTINATIONAL

CORPORATION

David William Komus

Ph.D.
University of Edinburgh

1981

D E C L A R A T I O N

I declare that this thesis has been composed by myself,
and that the work incorporated in it is my own

David W. Komus

ACKNOWLEDGEMENTS

T A B L E   O F   C O N T E N T S

L I S T   O F   T A B L E S   A N D   G R A P H S

A B S T R A C T

The thesis extends the theoretical work on the multinational corporation and on the reasons for foreign direct investment.

The reasons for foreign direct investment are considered by looking at a set of necessary and sufficient conditions for this type of investment to occur. This is extended by considering the range of objectives that a firm may have and by using the approaches of the managerial theories of the firm to look at the processes by which firms expand and diversify, where this includes expansion into foreign markets.

The multinational corporation was considered in terms of a mathematical model of a profit maximizing firm. The static models in the existing literature were reviewed by developing a more general model, that includes many of these as special cases. This was extended by developing a dynamic model. Two mathematical approaches were used; optimal control theory and dynamic programming. These were used to consider the response of the multinational corporation to changes in elements of its external environment such as, profit taxes, import tariffs, and market size. The responses considered included: qualitative changes in the levels of production and trade undertaken by the multinational in the two equilibrium positions; and the levels of investments and the adjustment in capital stock required to move from one equilibrium position to the other.

Chapter One

INTRODUCTION

Chapter One

I N T R O D U C T I O N

The multinational corporation has been steadily increasing in importance as one of the types of business organizations used to carry out commercial activities across international bound-aries. It can be defined as a firm that engages in industrial, commercial, or financial activities in more than one country, and has ownership and control of the foreign affiliates vested in a parent firm located in one country. It has been subject to a considerable amount of study, this proceeding along either theoretical or empirical lines and using the methods of a variety of disciplines.

This thesis extends the theoretical work on the multinational corporation using approaches from microeconomic theory. Both traditional profit maximization models and more recent managerial theories of the firm are used. The profit maximization approach is used in both static and dynamic models, where these models are developed mathematically. The discussion of static profit maximiz-ation models of the multinational corporation is a review and consolidation of the existing literature in this area. It goes beyond the existing literature in presenting a model that is general enough to include several of the existing models as special cases and to explain why some of the results of these models differ the

one from the other.   The dynamic profit maximization models are a new area in the theory of the multinational corporation.   Dynamic theories of this type have been used to consider the one-country firm but there has been no application of this type of model to the multinational corporation.

The managerial theories of the firm used in the thesis are those involving considerations of limited information and limited ability on the part of the firm to process and use information in its decision making process, and allowing for a range of objectives for the firm.   This is used in conjunction with the literature on the reasons for foreign direct investment by firms.   This literature is extended in the thesis by relating it to the range of possible objectives that have been attributed to the firm.   Then, the ideas developed in the managerial theories of the firm are used to develop an explanation of the process by which firms expand and diversify in order to further explain the process which leads to foreign direct investment.

The thesis initially considers the reasons for foreign direct investment and the managerial theory of the firm approach, and then considers the profit maximization models.   Thus, the process by which firms become multinational or increase the extent of their multinational activity is considered first.   The profit maximization models consider aspects of the operations of firms that are already multinational.

The second chapter of the thesis is used for some

3

preliminary matters. The definitions of the multinational

corporation and of foreign direct investment are considered in

order to provide a context for the later discussion. The range

of objectives that can be attributed to the multinational corpor-

ation is discussed, so that they can be referred to when the

reasons for foreign direct investment are considered.

A number of explanations of why firms engage in foreign

direct investment have been advanced. Foreign direct investment

involves the acquisition by the parent of the ownership and control

of a firm in another country. The acquisition of ownership involves

financial investment and it is the acquisition and use of control

that distinguishes direct from portfolio investment. There has

been some work on the consolidation of the literature in this area.

In chapter three the thesis extends this by adding to it a consider-

ation of the possible objectives of the firm. A situation where

different firms have different objectives, principally where multi-

national corporations and host-country firms have different objectives,

is considered and is found to modify the conditions required for

foreign direct investment to take place, from conditions developed

under the assumption that all firms have the same objective.

Foreign direct investment involves the expansion or

diversification of the firm. Chapter four considers this further,

using the approaches from the managerial theories of the firm to

consider the process by which a profit seeking firm could expand

and diversify. This allows for an improved explanation of why the

conditions found to be associated with foreign direct investment are important.

The profit maximization models involve a mathematical approach to the theory of the multinational corporation, and there is a shift in the range of questions considered. The reasons why firms become multinational are not considered but aspects of the operations of firms that are multinational are considered. In particular, the responses of the multinational to changes in its environment are considered. These changes can be changes in government policy affecting such things as profit taxes and tariffs on imports and the responses can be changes in the level of production in individual countries and in the level of trade undertaken by the multinational between those countries in which it operates.

A mathematical model requires that the multinational corporation be precisely specified. The models in the literature are two- or three-country models with one or two levels of production being undertaken by the multinational. Increasing either of these dimensions increases the complexity of the model.

The models in the existing literature are static. Chapter 5 provides a review and consolidation of them by developing a model that is general enough to include many of the features that are included in more narrowly specified models, thus allowing them to be treated as special cases of the general model. This allows for an explanation of the conflicting results that can be obtained from sets of the existing models. Conclusions concerning the

limitations on the interpretations of the results of these models are also drawn. The static model developed in the thesis is a two-country model where the multinational produces and sells a final good in each country, can trade the good between those countries, and also produces an intermediate good in one country that it uses in the production of the final good in both countries. The intermediate good is exported from one country to the other.

The dynamic model of the multinational corporation represents a new development. One model of the multinational was used with two different mathematical approaches, optimal control theory and dynamic programming. In the model specified in Chapter 6, the multinational is a two-country firm that can produce a single final good in each country and can trade that good between the two countries. All three options need not be used in every case and under certain conditions will not be used. This is a simpler model than the one presented in Chapter 5, but given the extension being made is a reasonable starting point. A similar starting point was used for the initial versions of the static model. As with the static model, the dynamic model can be extended and made more complex.

The two mathematical approaches used to develop the dynamic model have different strengths and weaknesses thus explaining the use of two approaches. Optimal control theory, as with the calculus used in the static models, uses parameters specified as variables or as part of general functional forms, such as

generalized production or demand functions, and seeks to obtain
necessary and sufficient conditions for a maximum while imposing
no or minimal restrictions on the range of permissible parameter
values and using functional forms that are as general as possible.
The model is developed in Chapter 7 but the results obtained, when
general functional forms are used, are rather limited. The
restrictions required to achieve more specific results involved an
assumption of a fixed capital to labour ratio in production.
These results were not developed at length as the dynamic programming
option is more useful if specific functional forms are required.

Dynamic programming is a numerical technique that uses
specific functional forms and numerical parameter values in order
to calculate a maximum. The range of functional forms and parameter
values that can be used with this technique is very wide and the
effect of changing either of these can be considered by changing
the functional forms or parameter values used in the model without
making major changes in the dynamic program itself. In this way
some of the assumptions required to obtain results from an optimal
control theory model can be avoided. The program used in the
thesis is specified in Chapter 8.

When the dynamic programming approach is used for
theoretical work the required functional forms and numerical
parameter values are assumed in order to illustrate the types of
responses that a multinational may make in a variety of circumstances,
where these circumstances are characterized by the parameter values

and functional forms. By varying the values assigned to individual parameters some impression of the importance of each parameter and of changes in its value can be obtained. The choice and range of parameter values used is specified in Chapter 8 and the results of the dynamic program are given in Chapter 9. Results are obtained for a variety of cases, including cases involving decreasing, constant, and increasing returns to scale in production.

Both of these approaches to the dynamic model can also be used in conjunction with empirical work. The parameter values and functional forms for the specific case of interest may be estimated empirically. The functional forms are used when the structure of the model is set up. In the optimal control theory version the parameter values are then used in the solution equations to the model. In the dynamic programming version the parameter values are used when the program is run. This application is considered for the dynamic programming model in the final section of Chapter 9, where possible extensions to and uses of the model are considered. This application was not considered for the optimal control theory versions of the model due to the restricted functional forms required in order to achieve results there.

Dynamic models can consider questions that cannot be considered by static models. Static models can look at responses to changes in the external environment in terms of the qualitative differences in the equilibrium position of the multinational before

and after the change. Dynamic models can look not only at the differences in the equilibrium positions but also at the process of adjustment from one equilibrium to another. For some changes, such as those involving a shift in the location of production, the adjustment period can be significant.

While the thesis is a theoretical work it does not ignore the empirical work that has been done. In looking at the reasons for foreign direct investment and developing the explanation of it using the managerial theories of the firm the relevant empirical literature is consulted to try to obtain further insights into the theory. No attempt at an exhaustive review of the literature is attempted, as the size of the literature would make that a major work in its own right. The mathematical profit maximization models, however, follow from an existing theoretical literature in which little reference is made to the empirical literature.

The purpose of this thesis is to extend the existing theory of the multinational corporation and, as a basis for this, to consolidate the existing theoretical work by using more general frameworks than hitherto established. The process by which foreign direct investment occurs is considered and the role of the firm itself, as opposed to external conditions, is highlighted. Dynamic models of the multinational corporation are developed, and their qualitative properties are explored using simulation methods. The dynamic framework developed also provides numerical procedures by

which the properties of models estimated from actual data on multinationals can be investigated.

.

Chapter Two

F R A M E W O R K   O F   T H E

A N A L Y S I S

Chapter Two

FRAMEWORK OF THE ANALYSIS

In order to study the multinational corporation (MNC) it is useful to specify what type of firm is considered to be an MNC. This chapter provides both a theoretical and an empirical definition of the MNC and then uses the empirical definition to specify size classes of MNC's. The range of objectives that can be attributed to the MNC is considered in the third section of the chapter. The range of objectives is an important consideration in chapter three where the reasons for foreign direct investment are discussed. Also, the objectives to be assumed in the mathematical models developed in the thesis must be considered.

2.1   DEFINITION OF THE MULTINATIONAL CORPORATION

The definition of the MNC should specify the principle features of the MNC and the characteristics that distinguish it from a non-multinational corporation. At the same time it is useful to consider the definition of foreign direct investment (FDI), as a firm becomes multinational by engaging in FDI. This section is also used to specify some of the terms that refer to the MNC and to make some distinctions between different types of MNC's.

The usual way of defining the MNC is to use a set of

criteria to divide corporations into MNC's and non-MNC's.   The set
of criteria can be extended to divide MNC's into different groups
or categories.   The criteria can be set out in two ways - they
can be specified in general terms or they can be given precise
numerical values.   The former is used for theoretical works and
the latter for empirical works.   As this thesis is a theoretical
work the definition will be largely set out in general terms.
Some aspects of an empirical definition of the MNC are considered
in section 2.2.

The criteria that have been used to define the MNC are
of the following three types: structural criteria, measures of
performance, and management attitudes to international business.[1]
The main structural criteria that have been used in the various
definitions are:

(1)   the firm conducts industrial, commercial, and financial
       operations across national boundaries;

(2)   the firm operates through a parent corporation in one
       country and through affiliates owned and controlled by
       the parent in other countries;

(3)   the firm is involved in the collective transfer of
       resources between countries;

(4)   the shares of the firm are owned by the nationals of
       several countries;   and

(5)   the top management of the firm is composed of the
       nationals of several countries.

---

1. Definitions of the MNC based on these criteria have been discussed
   by Aharoni (1971), and a definition based on four of these criteria
   can be found in Kopits (1976a, pp.626-627).

13

The first three of these structural criteria are more important than the last two. The measures of performance are based on the firm having a relative or an absolute amount of its resources committed to foreign operations, where the amount of resources may be measured by any of earnings, sales, assets, or number of employees. The measures of performance are similar to the first of the structural criteria. The structural criteria definitions are used mainly for theoretical works while the measures of performance definitions are used mainly for empirical work. The management attitude is that the top management of the firm has a cosmopolitan outlook, in that it has no special allegiance to any one national jurisdiction.

In using any set of criteria to define the MNC one can have the problem that the criteria exclude some firms that would generally be considered to be multinational or the problem that the criteria include some firms that would generally not be considered to be multinational. The purpose for which the definition is to be used will determine what type of definition is appropriate and will indicate where the line between included and excluded firms should be drawn. The definition required here is one that is useful for theoretical works.[1] Such a definition should concentrate on the essential features that distinguish a multinational corporation from a non-multinational corporation and will not be concerned with the fine detail of specific cases.

For this thesis the MNC will be defined as a firm that, (1) engages in industrial, commercial, or financial activities in

---

1. In a theoretical work the definition, if it is followed, will have some influence on the structure of the model, and the structure of the model limits the range of firms to which the model can be applied.

more than one nation, and (2) has ownership and control of the foreign affiliated vested in a parent firm located in one country. Under this definition firms whose international business is limited to exporting or importing are not considered to be multinational. This is standard to most definitions of MNC's and is appropriate as such firms do not have the same scale of international commitment as firms with investments abroad. Firms which have sales operations abroad are counted as multinational under this definition. Where the firm's primary activity is direct sales to consumers this is appropriate as multinational retailing firms can exist. Where the firm's primary activity is industrial and the foreign sales offices are designed to improve the exports of goods produced in the home country, the classification of the firm as a multinational is not entirely appropriate as the level of foreign investment will be relatively small for the firm. Such firms are usually not counted as multinational but it has been noted that establishing overseas sales offices can be a preliminary step to further international activity.[1]

In the models developed in this thesis the existence of overseas sales offices will not be considered separately from exporting without overseas sales offices. Firms whose international operations include manufacturing or extractive operations are included as multinationals under the definition given here. Financial institutions, such as banks, and service firms, provided they operate

---

1. Bergsten, Horst and Moran (1978, p.78, note 58).

in a number of countries can also be counted as multinational.

It is worthwhile noting that the MNC, as defined above, is in many ways similar to a one-country firm. In particular, the assumptions about managerial objectives, production technology, and other aspects of the firm can be carried over from the theory of the firm where that theory has been concerned with the one-country firm. The essential difference is that the MNC operates in multiple national jurisdictions and the one-country firm only in one jurisdiction. The significance of operating in multiple jurisdictions will receive further consideration later.

It should also be noted that the definition is general enough to apply to any MNC regardless of its size or the extent of its international operations, provided it operates in at least two countries. This is appropriate for theoretical work where the aim is to achieve reasonably general results. For some of the theories of the MNC developed or reviewed in the thesis the one-country firm may fit into the theory as a special case where the level in international activity by the firm is zero.

A firm becomes multinational by establishing or acquiring operations or subsidiaries in foreign countries. The process by which this is done is foreign direct investment (FDI) and therefore the nature of FDI will be considered. FDI involves not only the transfer of capital but also the transfer of a package of items such as: entrepreneurship; managerial skills; organizational skills; technology or other productive knowledge;

and marketing skills.[1]   The return on these items may be the reason for the firm becoming multinational and the capital a way of transferring these items.   This is further considered in Chapter 3 where the reasons for FDI are considered.   It has also been noted that FDI involves an entry into the market of one nation by a firm that established itself in the market of another nation.   Thus, the host country sees the subsidiary as foreign as well as the MNC seeing the host country as foreign.   The discussion so far has considered the foreign owner to be another firm and this is required for an MNC to be involved.   FDI can also occur where the foreign owners are individuals and not a firm but this is not very common. As this does not involve the MNC it will not be considered here.

It is useful to distinguish direct investment from portfolio investment.   Direct investment involves the purchase of both ownership and control while portfolio investment involves only ownership.   Thus, in direct investment the package of resources are transferred internally within the firm and control is retained over their usage.   In portfolio investment only capital is transferred. With portfolio investment there can however be a specific agreement to cover the transfer of other resources, but control over the use of the resources is not retained.

It is also possible to divide FDI into either a horizontal, a conglomerate, or a forward or backward vertical extension

---

1. The following discussion is based on Caves (1971, pp.1-4) and Dunning (1979, p.272).

17

to the existing firm.[1] A horizontal expansion involves the subsidiary in duplicating the activity of the parent firm by producing the same product or range of products. Forward vertical integration involves reaching beyond the parent's activity closer to the final demand for the product. Backward vertical integration involves linking the parent's activity to the supply of inputs. Conglomerate diversification involves cutting across product lines to engage in an activity unrelated to that of the parent.

In the above definition of the MNC it was specified that the parent firm owns and controls the foreign affiliates without specifying the level of ownership. In empirical work this is something to be determined from the data. In theoretical work a decision about how to handle this is required. The options are to assume 100 percent ownership of the subsidiary by the parent, to investigate the optimal percentage of ownership from the point of view of the parent firm or of the shareholders of the parent firm, or to explicitly consider joint ventures. All three of these options have been used in the literature on the MNC. The first is used to simplify the analysis and its use can be seen in the review of the comparative static profit maximization models given in Chapter 5. The second has been used on some of the theory of finance type models of the MNC which are not considered in this

---

1. The definition of these terms is taken from Kopits (1979) and his empirical evidence on the importance of each type of investment is reported in section 2.2.

thesis.   The third has received some discussion by a few of the

models of both of the above mentioned types.   In this thesis

100 percent ownership of subsidiaries will be assumed unless

otherwise specifically noted.

The definition of the MNC given above excluded any

consideration of the attitude of top management towards inter-

national business.   This was done because the attitudinal part

can conflict with the rest of the definition.   A firm can have

extensive international operations and still regard one country as

home or a firm can be interested in world wide operations but find

that its best option is to export from its traditional base.[1]

The definition given here has used the word

"corporation" since most multinational businesses are limited

companies.   It should, however, be taken to include multinational

businesses that are organized as partnerships or proprietorships.

Also no distinction is being made between the words "firms",

"corporation", or "enterprise".   In addition, no distinction is

being made between the term "multinational", "international",

and "transnational" although some authors have made distinctions

between some of these terms.[2]   In the thesis, when works by other

authors are referred to, each author's own terminology will usually

be replaced by the terminology used throughout the thesis.   In

addition, it should be noted that the foreign affiliates controlled

---

1.   For further discussion of this see Aharoni (1971. pp.33-34).
2.   One author to do so is Copithorne (1971, p.325).

by the parent firm can be established either as subsidiaries, separate host country encorporated entities, or as branches, legally a part of the home country parent.[1] As most foreign affiliates are organized as subsidiaries the term "subsidiary" will be used in the thesis, but in most cases the analysis will also apply to branches, unless otherwise specifically noted.

In considering the MNC it should be noted that its operations in each country (either home or host) can be relatively large and complex involving production, distribution, marketing, and management tasks, involving the operation of several plants, and covering a range of products. In much of the discussion of the MNC this complexity at the level of its component firms is ignored or simplified, and such a procedure will be used in this thesis.

2.2   EMPIRICAL MATTERS RELATING TO THE DEFINITION

It is possible to specify a definition of the MNC in empirical terms. This is necessary if the definition is to be used for empirical work and also makes it possible to specify size classes of MNC's. The concept of size classes is useful in some of the theoretical work but is best explained in the context of an empirical definition. In addition to specifying the size classes some indication of their importance is given. Some indication

---

1. This is noted by Robbins and Stobaugh (1974, p.4) as it is important for some of the financial questions they consider later.

of the relative importance of horizontal, vertical, and conglomerate diversification, by MNC's, is also given.

The importance of cross-investment between countries is indicated by the inclusion of appropriate data. Cross-investment occurs when parent firms in each country have subsidiaries in the other country. When the reasons for FDI by firms are considered the need to explain such cross-investment is taken into account.

The definition of the MNC used in empirical studies has varied from one study to another. A major study on MNC's was undertaken by the Harvard Business School and their definition has been used in a number of studies. One of these, Robbins and Stobaugh (1974, pp.10-11), defined the MNC as a firm controlling manufacturing or extractive subsidiaries in six or more foreign countries before 1965, where the firm was included on the Fortune list of the 500 largest United States industrial firms in 1963 and 1964.[1]

Using the above definition, size classes of MNC's can be distinguished and this was done by Robbins and Stobaugh (1974, pp.37-47). They specified three size classes, small, medium and large. Small MNC's were defined as enterprises with foreign sales of less than $100m in 1969. Medium MNC's were defined as enterprises with foreign sales between $100m and $500m in 1969.

---

1. Vernon (1971, p.11) also discusses the Harvard Business School definition.

21

Large MNC's were defined as enterprises with foreign sales greater than $500m in 1969. Their sample included 187 MNC's and 90 of these were classified as small, most of these operating in 6 to 12 countries with foreign sales accounting for 10 to 20 percent of enterprise total worldwide sales. Seventy-five MNC's were classified as medium, most of these operating in 10 to 20 countries with foreign sales accounting for 15 to 30 percent of enterprise total worldwide sales. Twenty-two MNC's were classified as large, most of these operating in more than 20 countries with foreign sales accounting for more than 33 percent of enterprise total worldwide sales. Other works have also made use of the concept of size classes of firms. For example, Williamson (1975, pp.181-182) refers to small, medium, large, and giant firms but does not specify the size classes empirically.

In the definition given above even the small MNC's are large firms. There are MNC's that are smaller than allowed for by the above definition and they are excluded from the study. In order to consider the possible importance of smaller MNC's one can look at data indicating the total numbers of MNC's. Robbins and Stobaugh (1974, p.10) found that in 1966 only 3700 United States corporations owned more than 50 percent of the stock in a subsidiary and that together these enterprises controlled almost 20,000 foreign subsidiaries and operated some 3000 branches. Under their definition only 187 of these were counted as MNC's. The importance of these smaller MNC's remains a subject for study. Some comments on them

are given in the next two chapters of the thesis.

In the previous section a distinction was made between horizontal, vertical, and conglomerate diversifications by MNC's. Kopits (1979, pp.101-104), using data on United States controlled foreign investment for 1962 and 1968, found conglomerate diversification to be of increasing importance accounting for 22 percent of FDI in 1968 while horizontal diversification accounted for 49 percent, forward vertical diversification for 22 percent, and backward vertical diversification for 7 percent. The percentages were found to vary considerably from industry to industry.

Certain relations between theoretical and empirical definitions and between theoretical and empirical work should be noted. These involve the size of the MNC and the number of products handled by the MNC. In most theoretical work the MNC is a two or three country firm with one of two levels of production, and a single final good that it sells to external customers. To meet the empirical definition the MNC must have subsidiaries in at least six countries in addition to its home base. Also, most firms have a range of products and not just one product.

The theoretical models are restricted in size in order to simplify the mathematics involved but, as indicated in Chapter 5, this may lead to results that appear to be much stronger than the results obtained with more complicated models. Models including more countries allow for a set of responses by the MNC to a change in its environment and some of these responses may partially offset one another.

Many firms deal in a number of finished products and semi-finished intermediate goods that fall within the same industry classification. This makes it difficult to compare theoretical and empirical results. Much of the data that have been used in empirical studies is based on industry classifications, thus covering a range of products instead of just a single product while theoretical models include only a single product. Empirical studies can show the subsidiary in one country as both shipping and receiving products from the same classification or as both producing and importing products from the same group. This does not necessarily mean that for any individual product either of these situations is the case although it does not exclude such a possibility. Some of the theoretical models considered later exclude such possibilities under certain conditions, but this does not imply a conflict between the theoretical and empirical results. To test the theoretical results empirical studies using data on individual products would be required.

Another point that can be illustrated with data is the importance of cross-investment between countries. This importance indicates that any explanation of the reasons for FDI should allow for such cross-investment and explains the concern with it in the next chapter. Its importance is illustrated in Table 2.1 giving the dollar values of FDI from and into the United States in 1979. It should be noted that cross-investment occurs in individual industries and not just at the aggregate level, although it need not occur in all industries.

Table 2.1 - FDI from and in the U.S. at year-end 1979

(1979 U.S. dollars)

	all industries	manufacturing						
		total	food products	chemicals & allied products	primary and fab- ricated metals	machin- ery	transpor- tation equipment	other manufac- turing
U.S. FDI in all countries	192,648	83,564	7,291	18,990	4,681	23,591	11,489	17,522
FDI in U.S. from all countries	52,260	20,029	5,562	7,081	2,971	3,343		4,072
U.S. FDI in Europe	81,463	41,246	3,396	9,776	1,995	13,515	5,300	7,265
European FDI in U.S.	35,999	13,487	1,608	5,254	1,534	2,071		3,082
U.S. FDI in Canada	41,033	19,237	1,733	3,248	1,266	3,895	3,644	5,451
Canadian FDI in U.S.	6,974	3,617	838	101	821	1,173		684

Source: Survey of Current Business, Vo.60, No.8, pp.27 and 47,
United States Department of Commerce
Bureau of Economics Analysis

2.3   POSSIBLE OBJECTIVES FOR THE MNC

The objectives of the firm have been the subject of a considerable literature. While most of this has been in terms of the one-country firm, much of it carries over to the multi-national setting with very little change. This section does not give a full review of this discussion, but is used to indicate the range of alternative assumptions that could be made, to consider some of the possible effects of adopting different assumptions, and to consider specific questions which arise when this discussion is applied to the MNC. The discussion can be approached from two points of view. One is to provide a reasonable assumption to be used in a theoretical model of the firm, especially where this is a mathematical model. The other is to provide a realistic description of the objectives pursued by the firm. Both of these will be given some consideration in this section.

In the discussion of the objectives of the firm a distinction is made between the owners or shareholders of the firm and the management of the firm.[1] This distinction is useful because it is not the firm as a single entity that sets the objectives which the activities of the firm will be directed to attaining but it is certain individuals or groups of individuals within the firm that set them. The two possible groups are the owners or the senior management and it is useful to consider the possible roles of each group within the firm.

---

1. There is a considerable literature related to this distinction. For one survey of it see Wildsmith (1973, Chapter 1).

The two groups considered here are the owners, usually shareholders, of the firm and the most senior management at the central or head office of the firm. The owners or shareholders of a firm have the ultimate control of a firm through their right to appoint and replace the directors and management of the firm. For this right to be effective the shareholders must be able to act in a unified way to vote out an existing management, and if the shares of a corporation are widely held, with no individual having a large block, this may be difficult to do. In this latter case effective control of the firm may go to the existing management.

Three types of control of a firm were distinguished by McEachern (1978): an owner managed firm, where the owners or principal shareholders also act as the managers or directors of the firm; an owner controlled firm, where there is a single or small group of principal shareholders who can replace the management of the firm but do not themselves take part in the management of the firm; and a managerial controlled firm, where the shares are widely held and it is difficult to remove the existing management. In order to consider the importance of these types of control McEachern looked at the growth rates of a sample of large firms classified by type of control and by the industry of the firm. He found that in the owner managed and the managerial controlled type the objective attributed to management, growth, was higher than in the owner controlled type. He concluded that the interest of the average

shareholder is best represented in an externally controlled firm.

It may be possible to relate the type of control to the size class of the firm and thus both to the size class of the MNC, as distinguished in section 2.2, and to the host country competitors of the MNC. This will be considered later and will be important in Chapter 3 when the reasons for foreign direct investment are considered. At this point it can be noted that for both large MNC's and medium MNC's, which are still large firms, it is reasonable to assume that managerial controlled firms will be the most common type although there will be some examples of the other two types. For small MNC's it is reasonable to assume that there would be a mixture of all three types. The same assumption could also be made for the host country competitors of MNC's as both of these latter two groups include a range of firms that would differ more widely in their characteristics than would large and medium MNC's.

Within the MNC the senior management and the management of the individual subsidiaries can have different objectives and the subsidiaries could be represented as owner controlled firms where the owner is not a private individual but is another firm. In this situation both sets of managers could emphasize objectives that are more strongly associated with management than with share-holders but the senior management would be concerned with the achievement of these objectives at the overall MNC level while the management of an individual subsidiary could try to achieve its

objectives at the expense of other parts of the MNC. The problems of the control of subsidiaries by the parent firm and the methods used to achieve this control are given further consideration in section 4.4 of the thesis where the organizational structures that can be used by an MNC are considered.

This discussion of the possible objectives of the MNC will note which objectives of a firm are likely to be associated with decisions to undertake foreign direct investment (FDI). In addition, any special conditions that must be associated with an objective if it is to lead to FDI will be noted. The discussion of the reasons for FDI is, however, the subject of the next chapter of the thesis and major consideration of this topic is deferred to there.

Before looking at the possible objectives of the firm it should be noted that the managers or owners of the firm may have an attitude that is favourable or unfavourable to FDI, independently of what their other objectives for the firm are. A favourable attitude to FDI can be characterized in a few ways. It could be a willingness on the part of management to spend the extra time and effort that foreign operations involve compared to domestic operations, where this could be due to the need to deal with or understand different languages or different business standards and traditions. It could also be a desire for foreign operations due to the prestige that this may contribute to the managers or owners. An unfavourable attitude could be due to the converse of

the first item listed or it could be an aversion to some perceived

risks of FDI or to a perceived higher degree of risk associated with

foreign operations than with domestic operations. This will be

referred to again when the reasons for FDI are considered and there

is some evidence from empirical work to support its importance in

that context.[1] This attitude is important in two respects. It

determines whether a firm is likely to be a leader or a follower

in undertaking FDI and it influences how strong any incentive to

FDI must be before a firm is likely to act upon it.

There are a range of possible alternative assumptions

that can be made concerning the objective of the firm. These can

be divided into two parts; assumptions about what the firm tries to

attain; and assumptions about how strongly the firm does or can try

to attain it. The latter includes maximization, satisficing,

or seeking. Assumptions are also made about the extent of knowledge

which firms have or can acquire about market conditions, technologies,

and other relevant facts and about their ability to make use of

this knowledge in making decisions.

Situations where the firm does not have full knowledge

can be described as situations of uncertainty. There are a number

of different types of uncertainty, including uncertainty about

the present or future values of relevant variables, and a number of

different approaches have been used to model uncertainty.[2] The

---

1. Horst (1975b, p.45).
2. One major discussion of uncertainty is Hey (1979).

31

different approaches to uncertainty will be given more consideration in Chapter 4.

The profit maximization objective is the most well established of the objectives that have been attributed to the firm and has been used both as a possible description of the firm and as an assumption in theoretical models of the firm. It can be combined with an assumption of full and certain knowledge of all relevant facts and can also be combined with assumptions of incomplete knowledge and uncertainty. It has been subject to a number of criticisms. One set of these is based on the distinction between the owners and the managers of the firm and is concerned with which group has effective control of the firm. The other set is based on the limits in the ability of the firm to acquire and use information, and claims that these limits are such that they make it impossible for the firm to carry out a maximization exercise.[1]

Two alternative objectives that have been put forward are the maximization of either the sales revenue or the growth of the firm, where these objectives are usually pursued subject to a minimum profit level constraint. These objectives can be combined with assumptions of either certainty or uncertainty, and have been used on theoretical models as well as being used as a description.

The objective of profit maximization is usually attributed to shareholders and the objective of sales revenue maximization or

---

1. One discussion of the alternatives to profit maximization is given in Wildsmith (1973).

growth maximization to management. The existence of capital gains due to the reinvestment of retained earnings by the firm and of differences in the rate of tax on dividends and capital gains makes the discussion of shareholders preferences for dividends or capital gains more complex. This point, which belongs to the theory of finance literature, will not be pursued here but is noted in order to indicate the possible complexities in this area.[1] Certain types of uncertainty that are discussed below also make the distinction between profit maximization and sales revenue or growth maximization less precise and the results of assuming different objectives less distinct. While a theoretical distinction between the different objectives may be clear any empirical measure of the distinction may be small and difficult to detect, for the reasons discussed below.

The assumption of profit maximization has been carried over to a substantial portion of the theoretical work on the MNC. It has been used both in models that assume certainty and in models that allow for particular types of uncertainty. One type of uncertainty that is particularly applicable to the MNC involves changes in or fluctuations in exchange rates.

An approach that has been used to look at the objectives of management has been to assume the existence of a managerial utility function defined over certain variables including any or all of profits, sales, growth, salary, security, dominance, and

---

1. For one discussion of this question see Mossin (1973)

professional excellence. This approach is consistent with FDI.
An attitude favourable to FDI could be represented in this frame-
work by including in the utility function the level of or the
presence of multinational operations within the firm. FDI could
also contribute to the prestige of the management as the operations
of the firm would be larger or more varied.

A different approach to the objectives of the firm is
to be found in those works based on a satisficing principle.[1] This
approach is founded on the cost of acquiring information and on the
limits on the amount of information that can be used in making any
decision. It concludes that management works to achieve satis-
factory levels of performance for the major variables that indicate
how the firm is doing, with management attention being concentrated
in those areas where performance is currently unsatisfactory. This
approach has not been used in the literature on FDI. Where such
variables as the rate of return or the level of sales are deemed
unsatisfactory FDI could be considered as one of the alternatives
that could be used to improve performance. Thus, a satisficing
firm could be led to FDI. A more reasonable case is where the firm
is a follower in FDI and other firms, with different objectives,
have already led the way. This will be considered further in
section 3.1 where the reasons for FDI are discussed. The concepts
of limited information and the limited ability to process information
are discussed further in section 4.1.

_____

1. For a review of this see Simon (1979)

34

Another alternative that has been used to deal with costly information and limited ability to handle information is to assume that firms use some form of "seeking" behaviour in trying to obtain an objective such as profits.[1] In this situation, where the management cannot maximize its objective, the management is trying to improve its attainment of the objective, which could be profits, sales, or any other item. In the case of profits it would do this by expanding activities that are making above average profits and contracting activities that are making below normal profits. Such a firm will also consider new activities and in the process of considering new activities could consider and adopt FDI. Thus, a seeking model is consistent with FDI. In considering new activities the firm will consider such items as: the characteristics it should give to its product; the number of competitors in the market; and the extent to which its product satisfied different demands than the competiting products. This objective is considered in Chapter 4 and particularly in section 4.3 where it is used in the development of a theory of the MNC.

In situations of incomplete information the distinction between profit maximization and growth maximization becomes less clear. If any large firm has an equal ability to find new opportunities for profitable activities there will not be a major conflict between expansion by the firm and returning the funds to

---

1. For one development of such a model see Lloyd, Rapport, and Turner (1975).

35

shareholders in the form of dividends so that they could invest in other firms, as they could not improve their return by doing so. Shareholders will adjust their portfolio to select, from the available opportunities, those that give them the combination of risk and expected return they desire. The distinction between profit and sales revenue maximization is also less clear. The effect of an increase in sales on profits is often not known and thus, the tendency will be to increase sales until profits turn down.

There have been some works that have looked at the objective of the MNC. One of these is a comparison of profit maximization and sales revenue maximization that was done by Horst (1974). In this, two versions of a simple model of the MNC were used to look at the amount of foreign sales and at the point at which the MNC would switch from exports to foreign subsidiary production, where foreign sales are growing over time. Horst found that the sales maximizing firm would at each point in time sell more than the profit maximizing firm, which is the usual result. He also found that the switch from exports to subsidiary production would take place at the same level of exports for both firms, although this would be at an earlier point in time for the sales revenue maximization firm due to the difference in the level of sales. There would also be a jump in foreign sales at the switchover point for the profit maximizing firm. The main conclusion was that the differences in behaviour due to the differences in motivation are so small that motivation cannot be determined from existing empirical data.

To determine motivation would require detailed information on costs and demand.

There are empirical studies that have been concerned with the objective of the MNC. A number of such studies were reviewed in an article by Stevens (1974).   Stevens first considered the difficulty of obtaining testable hypotheses from the different possible objectives where the hypotheses would be different for different objectives.   He noted that maximization of the market value of the firm under uncertainty is equivalent to profit maximization and also that a mean-variance portfolio theory explanation of investment can be made equivalent to profit maximization under uncertainty.   He was concerned with the alternatives to simple unconstrained profit maximization and concluded that:

> "there was not sufficient evidence
> to support the jettisoning of profit
> maximization; . in fact very little
> evidence supports the alternatives."[1]

The alternatives considered were growth maximization, the realm of behavioural theories, profit maximization or other behaviour subjected to financial constraints, and portfolio theories of the Markowitz variety.   In view of Horst's (1974) results and Stevens' discussion of the difficulties of obtaining clear tests to differentiate the hypotheses this conclusion is what one would expect. Stevens concludes by considering additional work that would be useful and the type of data that would be required for it.

---

1. Stevens (1974, p.78)

W.L. Beedles (1977) considered whether the firm has one goal or has more than one goal. This was approached from the point of view of research into the financial management of firms, where it is frequently assumed that the objective of the management of a firm is the maximization of the market price of its common stock. Beedles contrasted this to a situation where a firm had multiple goals, each one treated as an end in itself, where there would be interactive effects between the goals. The goals considered were the stock price, profits, and sales. To test this empirically he used data on three firms for the period 1929 to 1973, estimating his model using both ordinary least squares and two stage least squares. If the firm has one objective the former is the appropriate technique and if the firm has more than one objective the latter is appropriate. In order to compare the results he looked at the accuracy of the predictions obtained from each estimation, using five measures of the accuracy of predication. He found that two stage least squares was superior for four of the five measures and was always superior when the individual firms were considered and when the prediction of individual objectives were considered. He noted that there were limitations to his model in that population parameters, or the objectives of management could change over time. He concludes that he has presented evidence for the existence of multiple objectives and that the approach is worthy of further study.

This section has looked at a range of possible objectives

for the firm.   It is shown here and in Chapter 3 that most of these objectives are consistent with FDI.   It has also been indicated that present empirical evidence is not sufficient to decisively confirm, or to rule out, any of the possible objectives. Thus, it is useful to continue to consider theories that use a variety of these objectives so that the differences between them may be further illuminated.

In looking at the objectives of the MNC it has been assumed that the central management has an objective and directs the global operations of the MNC towards achieving it.   An alternative is to assume independent pursuit of the objective by the individual subsidiaries of the MNC.   A study by Stevens (1969) considers this empirically by looking at the level of investment in established subsidiaries.   Two alternative explanations of the level of investment are considered.   One is based on an assumption of global or joint profit maximization where all possible investment opportunities compete for the funds available and the levels of investment are decided centrally by the parent firm.   The second involves independent activity by each subsidiary where each subsidiary finances its own investment out of its own retained earnings.   Under the first alternative the parent firm may put new funds into an established subsidiary but it will not do so under the second.

Stevens (1969) used microeconomic data on 14 United States firms with 300 subsidiaries, 71 of which were considered to

be established subsidiaries. Using regression techniques he
tested models, based on the alternative hypothesis concerning the
objective, that explained the level of investment in the subsid-
iaries. He concluded that the only theory consistent with the
data for the level of fixed investment for the sample of 71
established manufacturing subsidiaries was a model of global
profit maximization subject to financial constraints. The
financial constraints involved an assumption that all investment
was financed from global retained earnings and depreciation allow-
ances. Stevens work supports the conclusion that a theory of the
MNC should involve some form of joint or centralized pursuit of an
objective instead of independent activity by individual subsidiaries.
He did not consider global alternatives to profit maximization so
did not contribute to the debate on what the overall objectives
of the MNC is.

The theories considered in the thesis use the assump-
tions concerning the objectives of the MNC in a number of ways.
The discussion of the reasons for FDI considers the range of
possible objectives. The modern theory of the firm approach uses
a profit seeking objective as its main assumption but gives some
attention to other objectives. The static and dynamic models
use an assumption of profit maximization. The static model, which
involves a review of the existing literature, follows the assumption
used in that literature. The dynamic models use the same
assumption so that the dynamic and static results can be compared.

The lack of evidence for the alternatives to profit maximization, noted when Stevens (1974) was discussed, is one of the reasons why profit maximization is retained in the mathematical models developed in the thesis. A second reason is the wide range of alternatives that could be used, with no single one having strong evidence to support it over the others. Beedles' (1977) conclusion in favour of multiple objectives opens the possibility of using any of a number of managerial utility functions that specify the importance of the objectives included in the function. In a mathematical model to change the objectives involves re-specifying and re-working the model. The difficulty of obtaining precise testable hypothesis discussed above suggests that the return to such a line of research may be small. The differences in the results may be small and the policy implications similar for a range of alternative objectives.

Chapter Three

REASONS FOR FOREIGN

DIRECT INVESTMENT

.

Chapter Three

REASONS FOR FOREIGN DIRECT INVESTMENT

One aspect of the literature on the MNC has been the explanation of the reasons for, or factors that lead to, foreign direct investment by firms. This has been considered both theoretically and empirically and there are a number of summaries of this literature.[1] There have also been some attempts to consolidate the literature in this area, most notably by Dunning (1977 and 1979). This chapter presents a consolidation and summary of the literature in this area. It then extends this discussion by considering the implications of alternative assumptions about the objectives of MNC's, where this includes assuming that different firms have more or less favourable attitudes to FDI and assuming that MNC's and local host country firms may have different objectives. The difference in objectives may be due to differences in the size or type of control of the different firms.

The consolidation of the theoretical literature, which builds on the work of Dunning, involves specifying a set of necessary

---

1. Some places where this literature is reviewed are Hafbauer (1975), Kopits (1976a, pp.628-633), Buckley and Casson (1976, chapter 3), and Hood and Young (1979, chapter 2).

and sufficient conditions that must be met if FDI is to take place. Brief consideration is then given to some theories that do not appear to fit into the framework provided by these conditions to see if they are either special cases that can be derived from the framework or are alternative theories to that presented in the framework.

The second section of the chapter looks at the empirical evidence reported in the literature and connects it with the theories presented in the first section. Some of the works on the reasons for FDI have combined theoretical and empirical considerations so some linking of these has already been done.

This section also reviews some studies that consider the trade off between exports by the parent and foreign production by a subsidiary and links this to the discussion of the reasons for FDI.

3.1   THEORETICAL EXPLANATIONS OF FOREIGN DIRECT   ·
        INVESTMENT

A number of theoretical explanations of the reasons for FDI have been advanced. Some of these presented sets of conditions that lead to FDI, where the basic conditions are the same but the statement of them differs from one work to another. This section presents one statement of the set of necessary and sufficient conditions and indicates why they are important, how they are related to each other, and the role that the objectives of the firm play in this. A number of theories that do not

explicitly use this set of conditions will then be considered. It will be shown that some of them represent special cases of or specific applications of the framework, while others represent alternative explanations of FDI.

In considering these explanations of the reasons for FDI it will be useful to keep in mind the definition of FDI in section 2.1 where FDI involves the transfer of a package of resources. The approach considered here is primarily concerned with horizontal and conglomerate expansion and is less applicable to forward or backward vertical expansion. Kopits (1979, p.99) maintains that conglomerate diversification by MNC's has been subject to very little study and considers some reasons for it.

The theories being considered presented the conditions in a variety of ways with the number of conditions also varying. This reflects a range of choice in how the conditions are presented. Dunning (1979, p.275) grouped these into three conditions that would have to be met if the firm was to engage in FDI:

1. The firm possesses net ownership advantages vis a vis firms of other nationalities in serving particular markets where these ownership advantages largely take the form of the possession of intangible assets and are, at least for a time, exclusive or specific to the firm possessing them.

2. It must be more beneficial to the firm possessing these advantages to use them itself rather than to sell or to lease them to foreign firms.

3. It must be profitable for the firm to utilize these advantages in conjunction with at least some factor inputs outside its home country, otherwise all production would take place in the home country and foreign markets would be served entirely by exports.

Attention will now be given to why each of these conditions is required if FDI is to take place.

A net ownership advantage is required because there are costs to operating at a distance which the MNC incurs but the local firm does not. These include higher costs to acquire information about host country market and other conditions than local firm, for reasons of much better access, will incur (see Caves 1971, p.5). These also include costs of controlling and communicating with a subsidiary over distance, where these may be increased if different languages, legal accounting requirements, or standard business practices or traditions are involved. In order to overcome these cost disadvantages and compete with local host country firms any MNC must have some offsetting advantage.

An additional condition that has been attached to the advantage (Caves 1971, p.4) is that it must be such that it can be transferred from one part of the MNC to another at reasonably low cost. In particular, this cost must be less than the amount it would cost the subsidiary to acquire the advantage independently. An alternative to this, not considered by Caves, is that the advantage be used by the parent firm in the production of a component of the final good and then the component be shipped from the parent to the subsidiary.[1]

The exclusive or firm-specific nature of the advantage is required so that local firms competing with the MNC are prevented

---

1. This idea resulted from a consideration of some of the ideas in Scherer, et.al. (1975), but there is no specific references for it.

from copying or adopting the advantage. This exclusiveness need
not be permanent. If the MNC can continually acquire or produce
new advantages all that is required is a sufficient time lag before
any individual advantage is copied by local firms so that the MNC
always has some advantage over them.

Two alternative ways by which a firm can obtain a
return on an advantage it possesses are to use the advantage
itself to carry out some revenue producing activity or to sell
or lease the advantage to some other firm or firms. The choice
between these alternatives depends on the costs and revenues
associated with each, with the costs of using market transactions
compared with the costs of internal co-ordination and control in a
single firm being particularly important. It is only when these
factors favour the use of the advantage by the firm itself that
FDI will result.

When the advantage is used in conjunction with factor
inputs outside the home country it must be the case that the
mobility of these inputs is limited or costly. In particular, the
costs of moving the factors must exceed the costs of operating in a
foreign country, otherwise the factors would be moved and FDI would
not take place.

Before going on to develop this explanation of the
reasons for FDI in detail it will be useful to consider the extent
to which it is consistent with the possible objectives of the MNC
as given in section 2.3.

The requirement that the MNC have some advantage over local firms is consistent with the objectives of profit maximization, or of maximization of sales revenue or growth of sales revenue provided that all firms have the same objective. Under profit maximization the advantage is required or the MNC's profits on FDI would be low because of their cost disadvantage. If sales revenue or growth maximization is the objective of all firms the advantage is required for a cost disadvantage would make it difficult for MNC's to obtain any significant market share in the host country. If, however, it is postulated that the local firms have profit objective while MNC's have a sales revenue objective then MNC's could operate without any advantage as they would operate at a lower level of profits than local firms would and this could offset their cost disadvantage.

The requirement that the MNC have an advantage over local firms is consistent with the objective of managerial utility maximization only if the management of the MNC's and the local firms have similar utility functions. If, however, the managements of some firms derive positive utility from the condition that their firm is multinational while other managements do not the former firms will tend to be multinational with a smaller advantage over other firms than they would otherwise require.

The satisficing and seeking objectives are both more applicable to situations of limited or incomplete information than to situations of full or perfect information. In the discussion

of possible objectives for the MNC it was concluded that the satisficing objective had only limited consistency with FDI activity by a firm. Since, under this objective FDI is used only in an attempt to correct an unsatisfactory performance in some aspect of the firm the existence of an advantage over local firms would increase the likelihood of FDI being seen as a way of improving performance.

The seeking objective is discussed in Chapter 4 of the thesis where consideration is given to a theory of a profit seeking firm. The theory looks at the diversification process of firms and uses it to explain how such firms become multinational. This theory embraces some advantages of MNC's over other firms. Under a seeking objective the objective can be any one of profits, sales revenue, or managerial utility. Thus, it allows for a situation of differing objectives where the MNC need not have an advantage over local firms. A seeking objective theory is, however, generally consistent with firms having different levels of efficiency, thus giving some firms advantages over others. The differing levels of efficiency or ability are due to the incomplete information assumed by the theory.

The condition that the MNC have exclusive use of its advantage depends on the requirement that the MNC have an advantage. If an advantage is not required the condition of exclusive use becomes empty. The second and third of the conditions for FDI to take place, that the firm use the advantage itself and that the advantage be used in a host country, also depend on the requirement

that the firm have an advantage. In a situation where the MNC
does not require an advantage there must still be some incentive
to FDI. This would be some condition favouring production in
the host country over exporting from the home country and could
be the use of a factor input from the host country that was included
in the third of the conditions leading to FDI.

In section 2.3 three types of control of the firms
were distinguished viz., owner management, managerial control, and
owner control, and their possible relation both to firms of different
sizes and to MNC's and local host country firms was noted. From
this one could argue for a difference in the objectives of MNC's
and local host country firms, with a substantial portion of MNC's
having objectives attributed to managerial control such as sales
revenue or managerial utility, while a substantial portion of local
firms would have an objective attributed to owners, namely profits.

A situation of differing objectives of firms has not
been considered in the literature on the reasons for FDI. One
way to fit this into the set of conditions developed above is to
consider as an advantage those objectives under which a firm will
emphasize growth at the expense of profits. The advantage based
on managerial objectives favouring FDI, could be found on its own
and could also appear in conjunction with other advantages. Such
an advantage is one that other firms could have, but not something
that could be directly copied. The third condition would still be
required in that the firm would need some incentive to operate

abroad. Since the objective can be related to the type of control of the firm, possession of the advantage would also be related to the type of control. Thus, if the type of control is important, there should be a relation between the type of control of a firm and the firm's level of FDI. The existence of an advantage based on the objectives of the firm would also help to explain which firms are leaders in FDI, as the total of the advantages of firms with growth objectives would exceed the total for other firms, so they would tend to engage in FDI sooner than other firms.

In discussing the advantages that the MNC has over other firms, the first step is to list the range of advantages that has been considered. These include:

(1) proprietary technology, usually where this is related to production activities;

(2) product differentiation or trade marks;

(3) a high level of skill in the managerial, marketing, or technical activities required by the firm;

(4) large size, where this reflects an ability to make use of scale economies that exist in the industry or to achieve economies in the provision of activities such as administration, and research and development, to the overall MNC (parent and all subsidiaries), or to achieve economies of joint supply; and

(5) large capital requirements for the particular industry in terms of the minimum investment required.[1]

In addition, there are also the advantages and disadvantages to

---

1. The list of advantages is constructed primarily from Dunning (1979, p.276). Other works using this approach are: Kindleburger (1969), advantage 1; Caves (1971), advantages 2; and Lall (1980), advantages 1 to 5.

operating in multiple national jurisdictions, which are discussed later in this section.

In the literature on FDI there has been little explanation of how the advantages arise. Part of the reason for this is that these advantages are also considered in the literature on the one-country firm, frequently in the context of market concentration and barriers to entry. Rather than summarize this literature many of the works on FDI just assume the advantages exist and make brief reference to the one-country literature. For example, Lall (1980, pp.103-104) claimed that the advantages listed are barriers to entry that give rise to concentrated market structures within countries, but does not go on the explain why.

There is, however, some limited explanation of these advantages in the literature on FDI. Dunning (1979, p.280) links some of the advantages to country-specific characteristics that are likely to generate and sustain them. Proprietary knowledge, which is primarily the result of research and development activity, is associated with government support of innovation and with the availability of skilled manpower. Product differentiation and trade marks are associated with national markets that have reason-ably high incomes and high income elasticity of demand and where there is an acceptance of advertising or other persuasive marketing methods. A high level of skill is associated with the availability of the appropriate type of trained manpower and with the existence of the appropriate educational and training facilities. Large size

is associated with having a large and standardized market and with
a liberal government attitude towards mergers, conglomerates, and
industrial concentration. Large capital requirements are associated
with reliable capital markets.

An advantage based on innovation activity represents a
situation where the advantage due to any particular innovation need
not be permanently protected from being copied by other firms. By
continuing to innovate the MNC continues to renew its advantage and
a period of protection, due either to patents or to keeping inform-
ation secret, is all that is required.

The types of advantages which MNC's have over other
firms will also be considered in Chapter 4 of the thesis where the
process by which firms diversify is considered. This is based on
the various firms having different levels of skills in the various
activities they undertake in order to carry out their business.

. Two additonal aspects of MNC's can be considered in
order to say more about the costs of operating at a distance and
about the types of advantages possessed by the MNC. These are that
a MNC operates in several distinct national jurisdictions, and that
it has multi-plant operations.

The effects of operating in several jurisdictions were
considered by Robbins and Stobaugh (1974, pp.21-35). They noted
that the risk of losses due to changes in exchange rates is endemic
to international business and is related to all major financial
decisions. The MNC has assets and liabilities denominated in

several currencies and carries out transactions between different currency areas. Changes in exchange rates can affect profits and will affect the recorded net worth of a subsidiary when it is translated into the home country currency. Further, the accounting principles used to translate assets and liabilities from one currency to another are complex and do not necessarily correspond to economic values.

Costs of borrowing differ between countries and MNC's can take advantage of this by borrowing in one country to use the funds in another country. This involves a risk that the exchange rate will change however, and the cost of using forward markets to cover this is almost equal to any losses due to the risk. Local borrowing, however, can offset the risk of having assets denominated in the local currency and can be used to establish local banking connections.

The tax structures to which MNC's are subject are complex, with subsidiaries subject to taxes in the country in which they operate, the parent subject to tax on its overall income, and there being complex rules about when income is counted as being received and about the credits allowed for foreign taxes paid. The MNC will use this by arranging its financial flows to minimise the overall amount paid in taxes.

Accepted accounting practices and legal requirments concerning accounting differ from one country to another. This causes problems when consolidated accounts for the overall MNC are being prepared. There are also other differences in business

practices between countries, and subsidiaries will frequently
follow local practices and not those followed in the home country
of the MNC.

The government in each country imposes a variety of
laws and restrictions on the firms that operate there and frequently
imposes special restrictions on foreign owned firms. For MNC's,
restrictions on new investment, capital flows, and the repatriation
of earnings are important. Also, import tariffs and quotas, and
controls on exports limit the ability of the MNC to move products
and semi-finished goods between its various subsidiaries and between
them and the parent.

The economics of multi-plant operations, including
a few comments on their role in MNC's, were considered by Scherer,
et al. (1975) and the following owes much to their work. They
compared the multi-plant firm to a single plant firm, where the
single plant firm was at or approaching the minimum optimum scale
when the effects of the costs of transporting the product to market
were taken into consideration. They also took into account the
fact that a firm produces a number of products, not just a single
product.

A multi-plant firm can concentrate production at one
or a few plants in two cases; where a product has high economies
of scale in production, or where total world-wide demand for the
product is small. It thus avoids either diseconomies of scale or
costs of co-ordinating and controlling multiple small production

runs for a single product. Where economies of scale are small or total demand high multiple plants at a number of locations can be used to save on transportation costs and, for an MNC, on tariffs and other costs of international trade. This is particularly important where there is some advantage to producing a full range of some type of product. Examples of this are household appliances where retailers or distributors want to purchase a full range from a single producer, or supplies of machined parts, such as screws, to industry where a firm prefers to purchase the full range required from a single source.

For the MNC the multi-plant advantage becomes an ability to produce products or components that are of low volume or have economies of very long production runs at a single plant which is used to serve several national markets. Thus, the MNC will be able to secure cost advantages not available to firms serving a single national market even if that firm has multi-plant operations in the one country. The production or final assembly of products that either do not require such long production runs or are subject to high tariff and transportation costs can take place at plants located in a number of national markets. The advantage of concentration of production may be particularly appropriate to components which are technically complex or of high quality as the MNC would only have to assemble one highly skilled work force. As components they may be subject to lower tarrifs than finished products and transportation costs may be less than for a finished product.

The local firms, however, retain one advantage over the MNC's. They can serve as a second and local source of supply. Not being dependent on goods or components coming from abroad they will not be subject to interruption due to disruptions in international trade. These can be due to stoppages or delays in international transportation or to changes in tariffs, quotas, or other restrictions on imports.

The next condition to be considered is that which causes the MNC to use its advantage itself by having a local subsidiary instead of selling it or licencing it to local firms. The main idea used here is the market internalization concept found in the nature of the firm literature, for which the seminal article is Coase (1937). A number of authors have put particular emphasis on this concept and have used it to try to explain why MNC's are common in some industries while they are uncommon in others. It has been argued that the markets for which internalization is most likely are those involving flows of commercially valuable information.[1] Where bargaining takes place under conditions of fewness, in the limit bi-lateral monopoly, the bargaining costs may be such that it is more efficient to internalize the market within a single firm than to bargain between firms.[2] This can explain vertically integrated MNC's, and in this case the MNC does not have to have an

---

1. Two works where this is developed at some length are Buckley and Casson (1976) and Casson (1979).
2. For a discussion of this see Dunning (1977, pp.402-408) and Dunning (1979, p.276).

advantage over local firms.

Market transactions in information involve certain problems, thus making internalization attractive. Once information is given it cannot be taken back but before the information is fully disclosed it is difficult for the purchaser to determine how valuable the information is. Although the use of information can be controlled by patents or other legal measures, partial disclosure often makes it easier for the firm obtaining the information to innovate in a way which gets around these restrictions. This is particularly applicable to information advantages obtained by research and development activities. Buckley and Casson (1976, p.42) also maintain that the flow of information concerning such matters as how well a product is received by customers, and how a product can be better suited to a particular market, is greater when the international transactions are internalized in a single firm than when the transactions take place between separate companies. This additional information flow can give the MNC an advantage in the market place.

Casson (1979, p.50 and p.95) noted that the incentive to internalize transactions in information depends in part on how well property rights in information are defined and could be reduced by improving those rights. With property rights better defined the FDI package could, in some cases, be unbundled and technology transferred separately. There are limits to this, because the return to proprietary knowledge goes to the entrepreneur

who recognises the opportunity for the use of the knowledge. Host countries could contract to have technology produced for them but some of them have only small amounts of the entrepreneural ability that is required to recognize opportunities.

Market internalization can be used under conditions of fewness to avoid bargaining costs. In these conditions it can also provide another advantage by improving the ability of the firm to make use of its oligoplistic position in the remaining external markets.[1] This occurs because the transactions of the now internalized market can be organized to suit the overall objectives of the firm instead of being the result of bargaining between two firms with separate objectives. In particular the quantity traded can be different as it is not involved in any distribution of profits between firms.

Market internalization can also be used in order to avoid the risks of default on a contract by one of the parties to the contract after the contract has been made. This is discussed by Klein, Crawford, and Alchian (1978). One example of this is the rental of an item of capital equipment. Once it is in place the renter may try to reduce the rent payable from the agreed rent to a level just above the level at which it would pay the owner to remove the asset and put it to another use. In the article a range of possible contractual arrangements and other alternatives are considered. In the multinational case an additional difficulty of

---

1. Buckley and Casson (1976, pp.37-38).

59

contracts is that one party may have to use the courts in the country of the other party in order to enforce the contract. This difficulty may increase the incentive to internalize the transaction by forming an MNC.

McManus (1972) also looked at the MNC as a method of co-ordinating economic or business activities in more than one country. He considered cases where the activity of a firm in one country had an affect on the return to the activities of a different firm in another country. Some of these cases, such as producing a commodity that other firms use as inputs, give rise to normal market transactions. Other cases, such as advertising spillovers where a brand name has been licenced, are much more difficult to handle by market transactions. In such cases a firm, by becoming multinational, can optimize the amount and type of such effects, given the objectives of the firm. Independent firms would have to reach agreement through bargaining and this would not be possible or practicable in all cases.

It is useful to consider whether or not market internalization by itself, in the absence of conditions 1 and 3, an advantage possessed by the MNC and its use in the host country, can give rise to FDI. When proprietary knowledge is involved, that knowledge provides an advantage and condition 1 is satisfied. Where the FDI involves only the establishment of a sales office in the host country condition 3 would not be required. This situation, however, is usually defined not as MNC activity but as

international trade activity. For more substantial foreign involvement that would be counted as MNC activity condition 3 would be required. For the vertical integration form of MNC, condition 1 (an advantage possessed by the MNC) is not required. Bargaining under conditions of fewness would be sufficient. The McManus argument involving spillover effects actually involves all three conditions. The spillover must provide an advantage or separate firms could compete effectively even if they did not reach any agreement. For example, if an advertising spillover did not reduce the total costs required to achieve a given level of advertising in the combined markets there would be no advantage to be gained by forming an MNC.

The final factor to be considered is why the MNC uses local production in the host country instead of serving the host country market with exports from its home country base. There are two main alternatives that have been put forward. One is that barriers to trade discourage exports and encourage local production and the other is that comparative advantages of the host country favour local production.[1] The barriers to trade can include tariffs or other restrictions on imports and also include transportation, insurance, and other costs of conducting trade over substantial distances. The host country advantages can include the size of the host country market and the opportunities to make use of scale economies, the prices of the inputs obtainable there,

---

1. See Dunning (1977, p.399) and Dunning (1979, p.276).

and the quality of those inputs including the productivity of labour, government policies including taxes and investment incentives, and the quality of the commercial, legal and transportation infrastructures existing in the country.

The barriers to trade argument provides a better explanation of investments that serve only the local market than it does of investments that produce products or components for a world-wide market. It can also be used to explain local production that involves only final assembly as tariffs or restrictions on components may be much lower than for the completed final product. This is consistent with an advantage that is embodied in the components shipped from the home country, while the MNC has no advantage in final assembly. The host country advantages argument provides an explanation for either type of investment but is more applicable to the case where the investment involves production for the world-wide market.

The use of host country production can also be linked to a consideration of the extent to which the advantage of the MNC is transferrable between the parent and the subsidiary. Lall (1980, pp.109-110) suggested the following hypothesis. A technology based advantage favours exports when the technology is being developed but later favours foreign production. Marketing skills favour FDI. Large minimum scales make the size of the market important and will delay FDI until the market reaches the required size. Technical skills will have a mixed effect depending on the skills involved.

It is the combination of transferability of the advantage with either barriers to trade or local host country advantages that will finally determine the choice between exports or production by a subsidiary in the host country.

The importance of cross-investment between countries was noted in section 2.2 and it is appropriate to see how well the set of three conditions presented in this chapter can explain cross-investment. This was considered by Dunning (1979) who argued that it is necessary for any theory to allow for cross-investment. Dunning noted that advantages may not be spread evenly across countries. The way in which specific advantages may be related to specific features of the country has already been discussed in this chapter. If advantages are spread unevenly, cross-investments may take place with the investments from each country being based on the advantages of that country. Also, each country will be a host country because of local factor inputs which it is advantageous for any foreign firm to use by establishing a local subsidiary. In Chapter 4 of this thesis, the explanation of the process by which firms diversity will be used to look at the development of cross-investment.

At this point it is useful to consider a few of the more specific theories or explanations of FDI that have been advanced. One of these is the product-cycle theory developed by Vernon (1966). The model has been outlined by Vernon (1979, pp.256-257) as follows. The stimulus firms have to innovate is

typically provided by the needs and opportunities of the market closest at hand, that is the home market. The home market will also be the preferred location for the actual development of the innovation due to the need for close communication with scientists and engineers and for contact with customers. Because of this importance of the home market the innovations of a firm headquartered in some given market will tend to reflect the characteristics of that market. The first production facilities will also tend to be located in the home market as this allows for quick communications between the different groups involved while product specifications and production technology are still changing.

In this model the advantage of the MNC is due to its innovative activity and is impermanent due to innovative or imitative activity by other firms. Initially the advantage will be used in foreign markets by exporting from the home country. The firm may later move to FDI, possibly because of the foreign market expanding and costs favouring such a move, but more usually because of the advantage being lost and costs becoming more important (Vernon 1979, p.257). The existence of some host-country condition favouring production is thus included in this theory.

The model was initially developed to explain FDI by U.S. based MNC's in the first and second decades after World War II. Vernon (1979, p.265) noted that it is less applicable now as MNC's have changed in character. MNC's are based in more countries and

these wider operations lead them to look for opportunities over more markets. The applicability of the product cycle model has been reduced but it still indicates that when market conditions change the MNC's based in the market where conditions change first will gain an advantage over those based in countries where conditions change later. Thus, it can provide some explanation of why FDI may take place in different directions at different times.

Another theory developed to explain an aspect of the FDI decision is the oligopolistic reaction theory of Knickerbocker (1973). This work found that FDI by United States bases MNC's in individual foreign countries was often closely bunched in time, with investment by a number of companies following the initial investment by some one company in a three to seven year period. Knickerbocker (1973, pp.21-29) suggested a set of motives that may lead to this behaviour. If a firm is successful in moving into a local market and establishing production facilities there it could strengthen its competitive position against other home country firms both in the host market and on a world-wide scale. The investing firm will have an increased productive base from which to compete in all markets and if its move is not followed will be the only one to include any potential advantages of having production facilities in its new host country. The investing firm may also have an advantage in the host country market. It is now protected against tariff increases or other restrictions on imports and may benefit from such changes if other firms do not follow its

investment.   Also, the firm may be able to use its position in the host market to help support its competitive activities in other markets.

In studying this investment pattern Knickerbocker (1973, pp.194-195) found that this industry concentration of foreign investment was positively associated with: the eight firm industry concentration ratio up to the seventy percent level but declining thereafter; the importance of marketing activities in the particular industry; the profitability of the industry; the rate of market growth in the host country; and is inversely related to the product diversity in the industry.

The oligopolistic reaction theory does not, as Knickerbocker (1973, p.9) noted, explain the initial investment in a particular country.   It can add to the explanation of FDI activity by firms that are followers but not leaders in FDI.   A firm can be a follower in FDI activity for a number of reasons.   It was noted previously that a firm that followed a satisficing objective would tend to be a follower and not a leader in FDI.   The ologopolistic reaction theory suggests why such firms would follow others in undertaking FDI instead of remaining a one country firm. Another set of followers are those firms where the management has an unfavourable attitude to FDI.   The leading firm not only shows that FDI in the particular country may be profitable but also changes the risks to the following firm, decreasing the risks of investing and increasing the risks of not investing, for the reasons mentioned above.

One additional consideration that a firm faces when undertaking FDI is whether to purchase an existing local firm or to start a subsidiary de novo. This does not appear to be discussed in the literature on FDI.[1]

To consider this the attributes that an existing firm can provide to the MNC should be stated. These include: a market share for an existing product range; established marketing and distribution arrangements; existing brand names, in the case of a consumer goods firm; production capacity using given techniques, for a manufacturing firm, where this consists of both physical plant and the labour force to operate it; and an established set of suppliers. It may also bring new products or technologies to the MNC, where these can be exploited on a world-wide scale. (Leroy, 1976, p.156.)[2]

The value of each of these will depend on the cost to the MNC of acquiring them for a subsidiary established de novo, how well the local firm corresponds to the type of subsidiary the MNC wishes to acquire, the quality of each existing aspect of the local firm, and the cost of acquiring the local firm. The value

---

1. For a discussion of related issues involving decisions concerning the replacement of existing plant and involving mergers or acquisitions see Scherer et al. (1975, pp.160-168).
2. For acquisition of a local firm to be a possible option, however, there must be at least one local firm of the appropriate type. If the MNC produce a highly specialized product range, perhaps involving advanced technology, there may be no local firms serving the same type of market, or producing the same type of goods. Thus, there may be no local firm that could serve as a subsidiary for the MNC.

of these to the MNC will also depend partly on what the MNC perceives its own strengths and advantages to be, and on how well the existing firm can be fitted in with the existing operations of the MNC.

The value of an established market share will depend on the presence and size of any market share possessed by the MNC based on imports to the host country, on the size of the local firm's market share, and on the size of the market share the MNC wishes to obtain. The smaller the MNC's import-based market share and the larger the local firm's market share the more attractive the purchase of a local firm is to the MNC.

The value of any brand names and established marketing and distribution arrangements of the local firm also depends on the extent of any export-based market share of the MNC. If the MNC uses international brand names the value of any local brand names is limited, although a publicity campaign associated with a name change to the MNC's own brand name may give them some value. The established distribution networks may be of more value to the MNC, particularly if it wishes to expand quickly from a small market share and limited market penetration to a large market share and much greater market penetration.

The value of any existing production capacity depends on its quality. This is determined by the technology embodied in the capital stock, on how efficient it is compared to the best technology available to the MNC, and on how productive the labour

force is. An existing plant is immediately available for production whereas it takes time to build a new plant and hire and train a labour force to run it. If the MNC's advantage is in efficient production technology this will reduce the value of any existing plant. The MNC will have to change the technology used in the firm purchased before the MNC can make use of its advantage, and this process will take some time. Also if the existing labour force is too large, or of the wrong composition, it can be difficult and expensive to change. If working practices are considered to be inefficient it can be difficult to change them in an existing firm, and it may be easier to obtain changes from conventional practices if a workforce is being hired by a new firm.

The existing suppliers to an established firm may or may not be valuable to the MNC. To the extent that the MNC wishes to acquire suppliers of components for use in the subsidiary from other parts of the MNC it will want to cease using local suppliers and there may be an adverse reaction to this in the host country. For a new firm, however, time will be required to establish contracts with local suppliers for those items that it wishes to acquire locally. This will involve management time, which will be a reasonable scarce resource when all the operations required to set up a new firm are involved.

The final choice between setting up a subsidiary de novo and purchasing an existing local firm will depend on the combination of costs and benefits involved for each of the above factors under each alternative. The MNC will also have to look at a number of

local firms to consider which would be the best one to purchase if such a course of action is decided upon.

The final consideration will be the cost of purchasing any firm and the ease or difficulty with which the firm can be purchased. It may be easier to negotiate with a single owner or small group of shareholders who own 100 percent of the shares than to make a bid for shares on the stock market. Also, negotiations with a group of shareholders can be kept private, while a stock market bid is public. To attempt to purchase control of a firm can increase the price asked for the shares of the firm.

This section has presented a set of necessary and sufficient conditions for FDI to take place and has shown that objectives of the firm that favour growth over profits may be an advantage to an MNC under this set of conditions. It then related a few of the existing theories to this set of conditions and also showed that the decision concerning purchasing an existing local firm or setting up a subsidiary de novo could be treated separately from the main set of conditions.

3.2   EMPIRICAL STUDIES OF THE REASONS FOR FOREIGN
        DIRECT INVESTMENT

A number of empirical studies have considered the causes of, or reasons for, FDI. These include specific studies and parts of studies concerned more generally with MNC's. This section reviews some of this literature in order to provide an

empirical comment on the theories presented in the previous section. This review serves its purpose by raising certain points for consideration and need not be exhaustive. The empirical studies have considered a number of questions including: the range of conditions that are associated with FDI; the role of diversification as a factor in FDI; and the relation between exports from the home country and production by a subsidiary in the host country.

The set of conditions that have been considered are given below, with a positive association with FDI being expected in each case. Then, the studies reviewed are listed with the conditions found to be of greater or lesser importance. The conditions are:

1. Research and development expenditures by the MNC, which are used as a measure of the technical advantage held by the MNC.

2. The size of the parent firm or of the overall MNC, usually measured either by sales or assets.

3. Measures of the degree of product differentiation or of the level of advertising by the parent.

4. A high level of marketing expertise being possessed by the parent firm.

5. A high level of capital intensity in the particular industry.

6. Measures of scale economies or of the minimum efficient plant size.

7. Measures of the skill levels required based on the proportion of technically trained employees to the total number of employees.

71

8. The importance of multi-plant operations in the home country.

9. The size of or the rate of growth of the host country market.

10. The size or importance of tariffs or other barriers to trade established by the host country.

11. Internalization of markets for information.

Items 1 to 8 represent advantages according to the theory given in the previous section. Item 9 is a condition involved in the choice of host country. Item 10 is one of the conditions that should lead to foreign production instead of exporting from the home country. Item 11 should lead to internal use of an advantage instead of licencing it to a local firm.

The studies reviewed are listed in Table 3.1. For each study, the second column lists the conditions found to explain or to be associated with FDI, while the third column lists the conditions found to have no significant association with FDI. Where a condition is not listed it was not considered by the study. Additional points from some of the studies are noted later in this section.

Table 3.1

Summary of the findings of the empirical studies

Study	Conditions found to be important	not significant	Type of Study
Spitaller (1971)	9	10	survey article
Forsyth (1972)	9,10		study of MNC's
Horst (1972b)	1,2	6	regression analysis firm level data
Caves (1974)[1]	1,8	6	regression analysis industry level data
Horst (1974b)	4,9		industry study
Buckley and Casson (1976)	11		study of MNC's
Franko (1976)	9,10		study of MNC's
Wolf (1977)	2,7		regression analysis industry level data
Buckley and Pearce (1979)	1,2.		regression analysis
Lall (1980)	1,3,6,7	5	regression analysis industry level data

Notes:

1. Caves (1974) found condition 3 to be sometimes but not always significantly associated with FDI.

There are some conflicts in these results, as conditions appear under different headings to be both significant and not significant. This occurs because some of the conditions are alternative causes or advantages with some, but not all of

them being present in any particular case. The ones found to be important in any particular study depend on the specific data set used. To explore this further a theory explaining why, and under what circumstances, the particular reasons for, or causes of, FDI are important is required. Some steps in this direction are taken in Chapter 4.

The relation of the above conditions to exports and to FDI was considered in some studies. Lall (1980) found that conditions 1, 6, and 7 favour exports and 3 favours FDI. Buckley and Pearce (1979) found 1 to favour exports and 2 to favour FDI. Lall (1980, p.119) concluded that the conditions that lead to internal concentration also lead to greater success in foreign markets and that transferable advantages promote foreign production while non-transferable ones promote exports. The latter conclusion was based on a comparison of a priori assumptions about transferability, with the above noted empirical results on which advantages explain each type of foreign involvement.

In a study on the foreign operations of the American food processing industry Horst (1974b) made a number of observations concerning the causes of FDI. For food processing firms an advantage in marketing skills was more important than any technical or production based advantage. This supports the suggestion that the different advantages are alternatives to each other. For some parts of the food processing industry domestic expansion was restricted by anti-trust decrees and foreign expansion appeared to

be used as an alternative to domestic expansion. In comparing

the firms that established foreign operations with those that did

not do so, Horst (1974b, pp.36-39) found that part of the difference

depended more upon the attitude of management than upon anything

else. This supports the inclusion of the attitude of management

among the causes of FDI. He also found that foreign investment

may improve a firm's competitive position at home over non-foreign

investors by opening up new opportunities for and defences against

predatory behaviour. In addition, the feed-back effect of FDI

may represent an increase in the barriers to new competition

at home.[1]

Robbins and Stobaugh (1974, p.4) in their study of

MNC's concluded that the most prevalent motive for undertaking FDI

was to meet a ⸗competitive threat. For a manufacturing firm this

could be a threat to an established export market and for an

extractive firm it could involve access to a better source of raw

materials. This partly reflects a desire to reduce risks and to

acquire knowledge about new markets. Other factors will be

important, but will be secondary to the main motive.

Wolf (1977) was primarily concerned with

diversification and looked at exporting, FDI, and domestic

industrial diversification as alternative parts of a single

diversification strategy used by United States manufacturing firms.

He found that exporting and FDI were alternative means of using a

---

1. Horst (1974b, p.119 and p.129).

75

technical or expertise advantage possessed by the firm as his

technical manpower variable was more closely related to the sum

of exports and subsidiary production than it was to either

individually. Domestic diversification to other industries,

however, was not as strong a substitute form of diversification

as exports and subsidiary sales were.

The relation between exports by a patent firm and

sales by a host country subsidiary were considered in an empirical

study by Horst (1972a). This was later reconsidered by Orr (1975)

who used more detailed data. Horst used data on 17 two-digit

United States industries and on their exports to and subsidiary

sales in the Canadian market, and concluded that there was some

form of trade-off between exports and subsidiary sales. Orr (1975)

used data on 71 three-digit industries and found no evidence that

subsidiary sales are substituted for imports, but did find evidence

that higher tariffs discourage imports. Orr, and Horst (1975)

in a reply, noted that the actual relation between exports and

subsidiary production may be complex and differences in the data

can change the results obtained.

In a study that looked at how a MNC would exploit its

products on the international markets, starting from the initial

development, Leroy (1976, pp.163-170) drew a number of conclusions

on the choice between exports and foreign subsidiary production.

These were that the need to differentiate a product across countries

favours local production while the novelty of a product or technology

and the complexity of the production process favours home production

and export. These conclusions were based on case studies of five firms looking at the activity and decisions with respect to individual products of the firms.

Leroy (1976, p.128) also noted that four of the five firms studied developed as multinationals along the same path. They initially became international with a unique product that had been a success in their domestic market. After achieving a dominant position internationally with the product they diversified into other product lines. They then developed a world wide outlook and saw the potential of any new technology on a world scale. The initial stage is consistent with the product cycle model discussed in the previous section, and the later stage is consistent with the decline in importance of the product cycle model.

Kopits (1979) looked at conglomerate diversification in the foreign operations of MNC's using observations on United States based companies in 45 two-digit industries. Diversified foreign operations were operations of foreign subsidiaries in industries other than the primary industry of the parent and this was measured by the proportion of diversified foreign subsidiary assets weighted by the number of industries in which the subsidiaries operate.

The factors considered as possible explanations of this diversification were:

(1)   research and development expenditures by the parent,

(2)   the size of the parent,

(3)   a proxy for the concentration ratio in the parent
      industry,

(4)   the growth of foreign subsidiary assets, and

(5)   domestic diversification by the parent.

Using regression techniques it was found that the first, fourth, and fifth of these were important although the overall level of explanation of the dependent variable was low. Support was also found for the view that horizontal and vertical foreign investment and domestic product diversification are complementary rather than alternative routes of corporate growth. The low overall explanatory power was attributed to variables left out, some of the more important ones being the degree of risk and uncertainty perceived by the investor, and country specific variables in the host country that may attract investment. The two items found to be insignificant, have no implications for whether or not they are important in explaining other types of FDI, and hence create no conflict with any of the previous results.

Some empirical studies have looked at diversification as a means of reducing the variance in the expected rate of return of a firm. Foreign diversification could provide a greater reduction in variance than diversification within the home country. A study by Miller and Pas (1980) which looked at product diversification, export diversification, and multinational diversification by 264 United States corporations provided evidence to support this conclusion. Using a mean-variance model of direct investment, and measuring risk as the deviation from a fitted trend in the net income to assets ratio and the operating income to

assets ratio, they found that multinational diversification had a
stronger relation to profit stability than did either product
diversification or export diversification.   In their work they
did not try to give any theoretical explanation of this result.

The empirical studies considered here have shown that a
number of conditions are associated with FDI.   The results are not
all consistent, reflecting the existence of alternative forms of the
conditions that lead to FDI, such as alternative advantages for the
MNC.   The studies have also found that FDI is part of a diversi-
fication strategy used by firms, but the extent to which FDI is
alternative to or complementary with domestic diversification and
export diversification is unclear.   The next chapter considers
this further by developing a theory of the diversification processes
of firms, where this theory specifically considers diversification
involving FDI.

Chapter Four

MODERN THEORIES OF THE FIRM

AND THE MULTINATIONAL

CORPORATION

Chapter Four

MODERN THEORIES OF THE FIRM AND THE MULTINATIONAL CORPORATION

Recent work on the theory of the firm has developed an approach that has explicitly considered the behaviour of firms under conditions where information is incomplete and is costly to acquire and where the ability of people to process and use information to make decisions is limited. This approach has seen only limited use in the study of the MNC. This chapter uses the ideas of this literature to develop a theory that explains the growth and development of MNC's. The resulting theory is used to explain the role of the various causes of FDI by indicating how, and under what conditions, these may be important. This allows for some of the conflicting evidence obtained in the various studies of the reasons for FDI to be explained. The theory can also explain cross-investments between two countries. The importance of this was noted in section 2.2 and in Chapter Three.

The work on this approach to the theory of the firm has been carried out by a number of authors including economists and individuals from other disciplines including business studies and the study of organizational behaviour.[1] Within the area there

---

1. For some discussion of this area see Simon (1979), Williamson (1975), and Caves (1980).

is some variation in the concepts and the methods of analysis used. In this chapter one approach involving a consistent set of concepts will be adopted whilst the possible alternatives that could be used will be noted in passing.

The first section of the chapter explains the type of theory being considered, indicating the choice of concepts to be used and explaining the reasons for the choice. Then, noting that MNC's usually start from existing one-country firms, a characterization of an existing firm is given as a starting point to explaining how such firms become multinational. This explanation is based on a model of the processes by which firms expand or diversivy.

4.1   TYPE OF THEORY BEING CONSIDERED

In considering this type of theory the concepts of limited information and bounded rationality should be explained and the objectives to be attributed to the firm or its management should be considered. The concepts of limited information and bounded rationality are best understood by comparing them with the alternatives of full information and perfect rationality. As required by neoclassical economics full information and perfect rationality involve: knowledge of all of the alternatives that are open to choice; complete knowledge of, or the ability to compute, the consequences of adopting each of the alternatives; certainty in the decision maker's present and future evaluation of

82

these consequences; and the ability to compare consequences, no matter how diverse and heterogeneous, in terms of some consistent measure of utility.[1] Under conditions of limited information the firm has actively to seek out information about what alternatives are available and about the nature and consequences of these alternatives. This will involve costs, both of time and of other resources. In addition, the possible information about the consequences of any alternative may be limited due to uncertainty about the future. Extending the concepts of full information and perfect rationality to a MNC involves assuming that the firm knows for all possible markets all of the items mentioned above, instead of knowing them for just one market.

The consideration of situations involving limited information has given rise to a substantial literature, covering a number of questions. This literature will not be reviewed here but the appropriate parts of it will be referred to as required. There is also a substantial literature concerning situations involving uncertainty and this too will be referred to as required.

Bounded rationality specifically refers to the fact that the amount of information that can be processed or used in any given amount of time in order to make a decision is limited. This limitation depends both on the limits of human abilities and on the limits of information handling and processing equipment, such as computers. Although this limit is being shifted outward

---

1.   Simon (1979, p.500).

over time it is never entirely removed and increasing
organizational size and complexity, which can occur when a firm
becomes multinational, can increase the importance of bounded
rationality.

The objective of the firm was considered in section 2.3.
Not all of the objectives discussed are consistent with limited
information and bounded rationality. In particular, maximizing
behaviour requires full information and perfect rationality.
This is independant of the particular item that is to be maximized.
The two main alternatives considered, both of which are consistent
with limited information and bounded rationality, are satisficing
behaviour and seeking behaviour.

The distinction between satisficing behaviour and
seeking behaviour was given in section 2.3. Briefly, satisficing
involves a situation where management watches several indicators
of company performance and concentrates its attention on those areas
where performance is deemed unsatisfactory. Seeking involves a
situation where the management has an objective, such as profits
or sales revenue, which it is always trying to increase, but which
it cannot maximize due to incomplete information and bounded
rationality. Seeking is thus the direct alternative to maximiz-
ation. It is to be noted that under conditions of uncertainty the
difference in the behaviour of firms seeking profits or sales
revenue may become small. Also, the difference between seeking
managerial utility over several variables, and satisficing

behaviour based on the same variables, may be small. In considering the MNC in this chapter it will be assumed that the management of the MNC follows a pattern of seeking behaviour where it tries to increase profits as much as possible. Some comments on other seeking objectives will also be given. In the section on the objectives of the firm it was noted that seeking behaviour is more consistent with FDI than is satisficing behaviour.

In considering how a firm pursues its objectives it will be useful to divide the decisions made by the firm into two categories; strategic decisions and operating decisions.[1] These categories are not mutually exclusive and can be defined as follows. Strategic decisions are concerned with the commitment of increases in the resources available to the firm to new or existing activities or with the switching of existing resources between activities. Operating decisions are concerned with the use of existing resources in the activity to which they have already been committed. The set of strategic decisions will be aimed at the firm's objective, here considered to be profits, and can be referred to as the corporate strategy, which would be a long run plan for attaining profits. Under alternative objectives it could be a long-run plan for attaining sales revenue on managerial utility. In addition to its corporate strategy a firm

---

1. These concepts are used in much of the organizational literature but are not always precisely defined. For a discussion of them see Caves (1979, pp.64-65).

has an organizational structure. This consists of: the internal allocation of tasks and responsibilities including lines of authority and communication; sets of decision rules and operating procedures; and procedures used for appraisal and reward. The organization structure is selected in the light of the corporate strategy in order to achieve the corporate objectives.

The senior management of any large firm is primarily concerned with corporate strategy and organizational structure while middle and lower management is concerned with operational decisions. The reason for this distribution of authority is that bounded rationality limits the number of decisions that can be made at any one level of management. Organization structure gains some of its importance through its influence on the decisions that will be made at the middle and lower management levels. In addition to their decision-making function all levels of management have a supervisory responsibility for the levels of employees below them.

4.2   CHARACTERIZATION OF AN EXISTING FIRM

MNC's generally develop from existing one-country firms, and to consider this process of development some points about existing firms will be noted. A firm has a set of products, markets, methods of production, sources of inputs, and management or head office operations. An important aspect of these activities is the efficiency or effectiveness with which they are carried out by the firm. This depends on a number of factors and can vary

widely from one activity to another.   Some approaches that have

been used to look at this efficiency are considered briefly below.

The obvious point to be noted here is that any firm, in the process

of carrying out its business, engages in a wide variety of activities

and carries out different activities with different degrees of

efficiency.   As noted by Caves (1980, p.66), firms competing in

the same market can use different combinations of inputs and

activities.   The combination chosen will emphasize the strength

and minimize the weaknesses of the firm.   This point will be

important when the processes by which firms expand or diversify

are considered.

The efficiency of a firm is determined by a number of

items including the following: the production technology used by the

firm and how recent or up to date it is;   and the degree to which

the employees of the firm are motivated to work to achieve the

objectives of the firm, which will vary around a norm depending on

the standards of diligence and effort that prevails in society at

any particular time and is related to the concept of x-efficiency.[1]

Another explanation of the situation where a firm has

an advantage in carrying out a particular activity can be found in

Nelson (1980).   He considered a case where the advantage was

specific to the firm and involved carrying out a particular activity

with a high degree of skill or excellence.   This skill or

excellence is a result of the experience and learning-by-doing

---

1.   Leibenstein (1976) and (1979)

that a firm acquires in carrying out its activities. Firms

will concentrate on products and methods of production that make

use of their particular skills and thus the experiences of

different firms will be different.   This type of excellence,

which involves more that basic skills, is difficult to transfer

to another firm and involves sending over a number of personnel.

It may be done to set up a subsidiary, where it would not be done

to sell the advantage to an outside firm.   Where the skill can be

used in the production of a component that can be shipped to a

subsidiary it may also be a basis for FDI as discussed in section 3.1.

The activities of the firm produce an outcome, or set

of results, including levels of sales and profits.   The objective

being considered here is profits, which in some cases could be

negative, i.e. losses.   It is not possible to assign profits or

losses to each of the activities of the firm.   The organizational

structure of the firm and the methods of cost accounting used will

determine the number of profit centers within the firm.   A profit

center can be defined as a set of related activities that produce

a revenue where all of the costs required to produce the revenue

are incurred by the particular activities or can be attributed to

the particular revenue source.   One example of this would be a

product division of a multi-product firm, where the revenue would

come from the sale of the product and the cost involved, production,

marketing, etc., are incurred by or attributable to the division.

For each profit center the recorded profit or loss will depend in

part on the degree of efficiency with which the various activities of the firm are carried out, and this will be the main factor in determining how these profits compare to those of competitors. The other factor determining the level of profits will be the state of a particular market. In an expanding market with high and increasing demand even a relatively inefficient firm may make profits while in a declining market even a relatively efficient firm may make losses.

The profits or losses made by, or attributed to, the different profit centers or activities of a firm will be one of the factors that is taken into account when the strategy of the firm is decided upon.

4.3   CORPORATE STRATEGY AND EXPANSION OR DIVERSIFICATION

Corporate strategy is concerned with the allocation of increases in the resources of the firm to new or existing activities and with the switching of existing resources between activities. There are several items to be considered in relation to corporate strategy: the range of options available to the firm; the evaluation procedures used to consider the options; and the time structure in which the whole process takes place.

The range of options available to a firm can be outlined as follows. One is to cut back or eliminate a particular activity. This differs from the others as they involve expansion or diversification. Horizontal expansion can involve: expanding

with an existing product in an existing market; using an existing

product in a new market; or introducing a new but related product

to an existing market. Conglomerate diversification involves

introducing a new product in a market that is new to the firm.

Forward or backward vertical integration are also possible.

The range of options that exist and are appropriate

to a particular firm will be larger than the range of options that

the management will be aware of at any particular time. More of

the options, and more details about any option, can be found by

some expenditure of managerial time and other resources. The

time framework in which the management of a firm makes its

decisions can be considered by using the concept of cause as

discussed by Hicks (1979, ch.7). Hicks is concerned with decisions

by economic agents and divides the sequence into two steps:

> "a prior step from the .objective cause to the decisions
> that are based on it, or influenced by it, and a posterior
> step, from the decisions to their (objective) effects."[1]

The option of reducing the level at which a particular

activity is carried out is always open to the firm, and can be

carried out in a number of ways. It can be done by failing to

make the necessary outlays to sustain the activity at its current

level, by laying off employees and storing or scrapping equipment,

or by selling off the part of the firm that is engaged in the

particular activity. The last strategy can only be used where

the part of the firm engaged in the activity forms a reasonably

---

1. Hicks (1979, p.88).

discrete unit and this will frequently be the case for the subsidiaries of a MNC. There may be some costs to cutting back an activity, particularly where redundancy payments must be made to any employees that are laid off.

There are a number of reasons why a firm can decide to cut back or eliminate a particular activity. This was considered for MNC's by Boddewyn (1979, pp.22-24) who listed several factors and these can be generalized to apply to all firms. Financial considerations such as poor performance, inability of the parent to sustain further losses, or lack of capital to finance necessary modernization is important but is more of a necessary than a sufficient cause. Adverse conditions in a particular market or activity, or in the host country, due to changes in regulations, union demands, or increases in competition, can cause an activity to be cut back or eliminated. Operations that do not fit in with the firm's major activities or that require a disproportionate amount of management's time can also be eliminated.

The options that involve expanding particular activities are only open to the firm when it has or can acquire the necessary resources. The sources from which a firm can acquire these re-sources include retained earnings and depreciation allowances, issues of new equity, and borrowing from financial institutions or by way of a bond issue. As noted previously, this thesis is not considering financial questions concerning the MNC. Thus, the questions involving the acquisition of financial resources and the choice of capital structure for the firm will not be considered here.

Another condition imposed on any possible expansion
is that there must be no external constraint limiting such expansion.
There are two types of limits to domestic expansion. One set of
limits are government-imposed through anti-trust and related
policies that limit expansion within the home country market. Such
policies usually do not limit foreign expansion by the firm. The
other set of limits are due to oligopolistic interdependence and
considerations of how a firm's competitors will react to any attempt
by it to increase its market share. It has been noted that firms
will try to avoid expansions that require substantial additional
market share.[1] Scherer et al. (1975, p.153) noted that new large
plants are sometimes put adjacent to low cost transportation
systems so as to minimize disruptions to existing marketing arrange-
ments. Expanding in a foreign market is another way of avoiding
disruptions to the domestic market.

The decision to expand or cut back an activity depends
not only on the resources and condition of the firm but also on the
state of the market. Expansion of an existing activity will be
easier to carry out where a market is expanding and increased sales,
with a constant market share, are available to all firms; but will
be more difficult in a stationary market where increased sales must
come from the market shares of other firms. In the latter case,
expanding by purchasing an existing firm may represent a useful
alternative.

---

1.   See Scherer et al. (1975, p.155) and Sylos-Labini (1969,
     pp.100-101).

One type of new market for an existing product of a firm is the market in a geographic area or country where the product was not previously marketed. Going into a new country involves establishing, or increasing the extent of, the multinational operations of the firm. This can involve either exports or setting up a foreign subsidiary. Only in the later case does FDI take place.

The rate at which a firm can expand or diversify is limited, due to limitations imposed by the resources available to the firm. The process of investigating opportunities and making decisions is itself costly and time consuming. Aharoni (1966) found that it was usually broken into two phases, a check of available indicators to form an opinion of a project, and, if the project was not dropped, a more detailed investigation. He also found that firms tended to look at single projects and did not always compare alternatives.

The sources and amounts of funds available to the firm were already mentioned, but their use also involves questions of liquidity.[1] A firm with funds available from internal sources or with sources from which it can borrow quickly will be able to meet the financial commitment required to take advantage of an opportunity that may come along, while a firm that has no more funds available will have to delay. Thus, by taking advantage of one opportunity a firm may reduce its ability to take advantage of

---

1. Hicks (1977, pp.77-79).

other opportunities that appear in the near future.

For an MNC the location of its available funds is important.[1] Its funds will be in a number of currency areas, and government controls on capital movements will limit the speed with which the funds can be moved from one area to another. The financial flows involved in moving funds also have tax implications and the MNC will desire to minimize the taxes payable, while having the funds where it needs them. Changes in the exchange rates can also influence financial flows and this was considered in Chapter Three, where operations in multiple national jurisdictions were considered.

The procedures by which alternatives are evaluated have been considered, for a profit-seeking firm, by Lloyd, Rapport, and Turner (1975). For existing areas of the firm the rule of expanding those making above normal profits and contracting those making below normal profits can be used. This rule works best where the areas are well defined profit centers, and is used because the information required is available to the management as part of normal business activity. Subsidiaries of MNC's can be organized as profit centers, and the conditions under which their profit figures are likely to be accurate as a guide for decision making will be considered later. Some of the conditions that lead to above or below normal profitability were discussed in the previous section.

_____

1. The flows of funds within MNC's are considered by Robbins and Stobaugh (1974) and the following points have been noted from there.

94

A similar decision-making rule applies to a sales revenue seeking firm. Areas with high profits will be expanded but expansion will stop when profits fall to a constraint level and not to some normal level. Similarly, an area will be contracted only if profits are below a constraint, or in the more extreme case negative, instead of when they are below some normal level. For either objective, it is only when low profits are expected to persist that the activity will be cut back.

The decision rules used for considering new areas are more complex and a brief digression on what is involved in diversification is appropriate. The adding of a new product, market, or other activity to a firm is a diversification move. The new activity will in some way and to some degree be related to the existing activities of the firm. This relation can involve the use of similar production technology, the use of existing research and development skills or results, the use of existing product designs or marketing skills, and to a lesser extent the use of managerial resources that are particularly skilled at controlling certain types of activities.

The more closely the new activity is related to an existing activity the more information about it the firm is likely to have. Also the costs of gathering and processing additional information about it are likely to be lower as the firm will have some idea of what type of information is most useful, where is the best place to start looking for it, and how it is to be interpreted

and processed. Also, the more useful will be the existing skills and resources of the firm and the fewer the new skills and resources that it will have to acquire. The more efficient or proficient the firm is in the use of the skills that are related to the new activity, the more likely it is that the firm will be relatively efficient in the new area and thus able to compete effectively.

In considering any diversification move the firm will consider certain characteristics of the market that it is proposing to enter. Lloyd, Rapport and Turner (1975, pp.128-129) suggest the following. The profitability of the firms already in the industry is a weak guide, but profitability will vary between these firms and the firm considering entering the market will only want to do so if it can make a reasonable profit there. The characteristics of existing products and the amount of space left in the market for a product with a different arrangement of characteristics is important. The more the product characteristics can be varied the less the extent to which the firm's product will compete directly with existing products. This can explain why some studies of the reasons for FDI found advertising and product differentiation or a high level of marketing expertise to be important, as they are associated with markets where product characteristics can be varied. Another factor is the size of the market in relation to the minimum scale of operations needed for profitable operations. The more firms that an industry can hold the more likely it is that the firm can achieve at least the minimum efficient scale. The firm will not

have precise knowledge of these market characteristics but will have some estimate of them.

The same set of characteristics will be considered by a sales revenue seeking firm but the emphasis will be changed. The firm will look for large potential sales at or above a minimum profit constraint. Where a firm is seeking managerial utility the emphasis will be on those items that contribute to managerial utility. As noted in section 2.3 this could include having foreign operations.

When the diversification possibility considered involves going into a market in another country this can lead to multinational activity, initially exporting and later FDI. For a firm, exporting an existing product may be more closely related to its existing activities than diversification to a new product or market at home. Once exporting is undertaken FDI in that market will become more closely related than it was previously. This can be part of an explanation of MNC's that are of relatively small size with a narrow or specialized product range.

The process by which management considers new opportunities will now be considered.[1] The process involves: becoming aware of possible opportunities; gathering information on opportunities that look promising; and making a decision.

The first stage is usually unstructured and involves accepting information that becomes available to the firm. A systematic search for all possible opportunities is time consuming

---

1. The discussion of this is based partly on Aharoni (1966).

and expensive and will be used only when management believes that the opportunities it is aware of are significantly inferior to others that should be available, or when management decides it wants to diversify into unrelated activities to obtain advantages such as a more stable return. Unsystematic search tends to reinforce the tendency of firms to move into activities that are related to existing activities, as it is these that it is most likely to receive information about.

Aharoni (1966, pp.54-55) found that there were several sources of information about opportunities abroad that could lead to FDI: a foreign government; the company's distributors, suppliers, or customers where these are other firms; and representatives of other firms. These are sources that it may be difficult for the firm simply to ignore. The movement of competitors or customers abroad can also be a signal that causes FDI to be considered. The reaction to such information will depend in part on the attitude of management and of the individuals receiving it to new opportunities, including opportunities involving FDI. The more favourable the attitude, the less detailed the information can be and the less important the source can be, while the information is still acted on.

The process of considering new opportunities which has been described can give rise to a general pattern of expansion for firms. The first method of expansion will be in existing profitable markets at home. The next will be to related markets

at home, where these can be related in any of the ways mentioned above, including similar products, production technology, or marketing skills, or the ability to add new products to an existing distribution network. The final will be foreign activity, first exports and then FDI. If the firm's initial markets are not profitable, the relation used will involve production skills, technology, or marketing skills, and not particular products or their uses. Unrelated activities will be considered where related ones do not appear to be profitable.

There are variations to this pattern depending on the size and type of firm involved. Small firms that are suppliers to larger firms may follow such firms abroad. The small firm may see this not so much as diversification but as a defensive measure designed to protect its position as an important supplier to its customer.

The pattern postulated, particularly for profitable products, can be used to explain some of the observed characteristics of MNC's. These were described in section 3.2 where some empirical evidence on the reasons for FDI is presented. The relation between the size of the parent firm, or the overall MNC, and FDI is explained by the tendency of firms to expand at home before considering activity in foreign markets. The importance of the size or rate of growth of the host country market follows from the tendency of firms to look at relatively large diversification opportunities. This tendency exists because the costs of investigation will be largely independent of the size of the opportunity, and it also

explains the observation that subsidiaries tend to be among the larger firms in the host country. The conflicting evidence concerning the effects of minimum efficient scale can also be explained. The tendency to look at large opportunities should lead to a large minimum efficient scale while the tendency to look for markets that can hold a reasonable number of competing products and firms should lead to a small minimum efficient scale.

The importance of research and development activity has been explained by other theories but is consistent with the above presentation as an important skill area that is related to a large number of commercial activities, thus giving the firm a considerable range for possible expansion or diversification. Having a high proportion of technically trained employees in the work force of the firm is consistent with an explanation based on the firm carrying out some activities with a high level of skill. Again, this is something that could be related to a large number of possible commercial activities.

For the pattern of diversification presented above domestic conglomerate diversification and foreign horizontal or vertical diversification will tend to be alternatives. By starting in any direction a firm will relate more activities in that area to itself and thus may continue in the same direction. As a firm continues to expand it may use up the opportunities in one direction and switch to another direction. Thus, a firm that has been growing for some time may exhibit both types of

diversification. A study of how firms expand and diversify over time would be needed to determine if the types of diversification are alternatives or are complementary, as studies using cross sectional data could show either result depending on the firms included in the sample.

The process of diversification described above can provide some additional explanation of the nature of the advantages that a MNC may have over local host country firms.

Some advantages will lead to FDI in countries with similar markets to the home country, where this is defined in terms of the incomes and tastes of consumers. Advantages which can be embodied in product design, such as those due to research and development activities, require similar markets to allow the same product, or minor variations of the product, to be sold on both markets. An advantage based on marketing skills requires similar markets if the same type of marketing techniques are to be effective. Such a skill area, which is embodied in a relatively small and specialized staff, can be transferred by sending a limited number of staff to the subsidiary.

Advantages in production may or may not be difficult to transfer. If the advantage can be embodied in a component of the final good it can be transferred by shipping the component from the parent to the subsidiary. If the advantage results from specific production techniques or arrangements it may be possible for a limited number of plant management personel to transfer these to a

plant in another country. This will be easiest when the general
skill levels and standards of the workforce are similar. If the
advantage depends on getting a high level of performance from the
firm's work force it may be difficult to transfer as it may take
a long time to get a new work force up to such a level.

The process of diversification considered can also
be related to a situation where firms have a variety of objectives.
In considering this, the point, noted previously, that firms often
consider single opportunities and do not compare opportunities,
will be used. A firm with a growth objective instead of a profit
objective will tend to grow faster and consider opportunities at a
faster rate. Thus, such a firm may use up its domestic opportuni-
ties and consider its foreign opportunities sooner than it otherwise
would. It has also been noted that a favourable attitude to FDI
on the part of managment will lead to a more favourable response to
foreign opportunities. This could be combined with any objective
so the results will not be clear-cut for an objective considered in
the absence of the attitude to FDI.

The importance of cross-investment was noted in
section 2.2 and discussed in Chapter Three, where it was noted that
the advantages possessed by MNC's will not be spread evenly across
countries. Under the theory presented here the types of advantages
possessed by firms can vary within, as well as across, countries.
The point added here is that firms will tend to set up foreign
operations in countries where the markets are to some extent similar

to, or related to, its home country markets. Such a relation will go in both directions, thus making FDI in the reverse direction attractive to firms based in the other countries. The reason for host country production instead of exporting from the home country remains the use of local factor inputs.

The explanation of which firms, from a given country, will tend to become MNC's and which firms will tend to remain one-country firms depends on: which firms are most efficient; which firms have an objective favouring growth over profits; and which firms have a favourable attitude to FDI.

4.4   STRUCTURE AND ADAPTABILITY

Any firm concerned with expanding must adapt to new opportunities and circumstances. The organizational structure of the firm will both result from and influence the process of adaptation. The literature on this is limited and Caves (1980, p.81) mentions it as an area that needs further research.

The choice of organizational structure is influenced by the need to economize on managerial time due to bounded rationality, the requirement for each level of management to monitor performance at lower levels of the firm, and the requirements for adaptability. The combination of these factors will determine the organizational structure that best suits the firm at any point in time, with this structure changing as the size and range of activities of the firm changes.

Two main types of organizational structure have been described in the literature, the unitary form and the multi-divisional form.[1] In the unitary form the firm is organized along functional lines such as sales, manufacturing, finance, and engineering, with management for each functional area reporting to the senior managment of the firm. Profits cannot be assigned to functional areas as they do not see any product through all stages from inputs of materials to final sales. The multi-divisional form is organized along product or geographic lines with each division having a unitary form organization and carrying out the full range of functions required by the division. Each division reports to the head office of the firm and can be treated as a profit center, as a full set of revenues and costs can be assigned to it. The operational decisions should be made by the individual divisions while decisions about corporate strategy should be made at the head office.

Certain additional types of organizational structures have also been defined.[2] The holding company is a divisional enterprise but lacks the internal controls that are present in a multi-divisional company. A transitional multi-divisional is an enterprise that is in the process of adjusting, and the relations of the divisions to the parent are still being developed. A corrupted multi-divisional is one with a structure where the general management

1. For one discussion of these types see Williamson (1975, pp.132-141).
2. Williamson (1975, pp.151-154).

has become extensively involved in the operating affairs of individual divisions. The mixed multi-divisional occurs where some divisions are under loose holding company control while other divisions, because of their importance, are under close unitary control.

A range of organizational structures can be used by MNC's.[1] The unitary form, with the functional areas of the subsidiary reporting to the corresponding functional areas in the parent, is possible provided that the parent firm has a unitary form itself. It is only likely to be used if the foreign operations are a relatively small part of the total operations of the firm. The geographical proximity of the home and host countries, so that they could be seen as a single market, would increase the possibility of this type of structure. For a vertically integrated MNC a unitary form could be appropriate. The subsidiaries involved in resource extraction would be part of the functional division controlling the extractive activities of the firm in the home country and in any host countries.

A second form is a multi-divisional structure based on product groups. This would require that the subsidiaries also be divided into product groups and each group within the subsidiary would come under the corresponding group of the parent. The

---

1. For some empirical studies of the organizational structures used by MNC's see Litvak, Maule, and Robinson (1971) and Robbins and Stobaugh (1974).

subsidiary's head office would have no control over its individual divisions and its main function would be to prepare such consolidated financial statements as are required for tax or other purposes. Such an arrangement can work where the host and home country markets are closely connected but may not be practical in other cases.[1] Such a structure also assumes that any benefits of coordinating the activities of the product groups within the host country are outweighed by the costs of doing so. With such an arrangement it would be possible for each division in the host country to be a separate subsidiary. This can explain some of the cases where a parent has several subsidiaries in one host country.

A third form is a multi-divisional structure where the divisions are based on geographical areas. The foreign subsidiaries would report to a divisional head office that could be located in the home country or in one of the host countries in that geographic area. The divisional offices would in turn report to the general managment at the head office of.the parent. The simplest version of this is where all subsidiaries report to one international division, the geographic divisions being the home country and the rest of the world. As the number of subsidiaries and host countries increases the number of geographic divisions can be increased.

Where a regional structure is used there will also be a structure within each region, and within each subsidiary. The unitary form and the product division could be used and their

---

1. See Litvak, Maule, and Robinson (1971, pp.53-60).

advantages and disadvantages would be much the same as previously discussed for an overall MNC. With product divisions, however, the head office could also have head office groups concerned with each set of products, to improve the flow of product related information between geographic divisions. Some discussion of the use of this type of structure is given in Caves (1980, pp.75-76).

Within a multi-divisional firm the central management has a problem of evaluating the performance of the individual divisions and within a MNC there is a need to evaluate the performance of individual subsidiaries. Robbins and Stobaugh (1974, pp.143-160) examined this in their study of MNC's. They noted that the rate of return on investment is used as one of the measures of performance but there are difficulties with it. When the MNC is run as an integrated system it is difficult to allocate profits to individual subsidiaries. If transfer prices, management fees, or royalties are used as a means of shifting profits for tax purposes the stated profit or return figure may not be an accurate measure of the subsidiary's performance. The budget is also used as a tool for evaluating performance and there are both capital budgets and operating budgets. The budgetary procedures are standardized across the MNC, with management trying to make sure that suitable objectives are included in the budget for each subsidiary. These budgets are usually approved at the highest levels of managment in the head office.

There is some relation between the size of a MNC and its

structure. It has already been indicated that as the size and number of foreign operations increase the number of divisions used to control these operations will increase. Thus, this relation is best looked as the process of adapting the structure of the MNC to changes in the MNC and its environment is considered.

Changes in structure can result from expansion or diversification and can also occur independently of any other change, in order to improve the operations of the firm, including improvements due to improved control. There are a number of different types of changes that can be made to the structure including: (1) the addition of new functional areas or operational divisions; (2) assigning new responsibilities to an existing functional area or operational division; (3) the addition of new staff departments to the head office; (4) changing the procedures of the firm and; (5) changing the lines of communciation and authority. Substantial modifications of the structure in order to improve the operations of a firm often appear after a period of expansion or diversification. The modifications to the structure made during the period of expansion often give rise to problems or inefficiencies which only become obvious later, leading to further changes. In considering changes in structure the distinction between small, medium, and large MNC's, made in section 2.2, will be useful. The growth of a firm from one size class to another can be important in this context.

There are costs to making changes in the structure and

these will have to be considered in addition to considering the incentives to change the structure. The first point to consider is the factors that influence the choice of structure.

One of the factors that will influence the choice of structure by a MNC will be the effect of any structure on the flows of information between the different parts of the MNC. In particular, there will be little incentive for divisions to share intangible assets such as productive knowledge and skills with other divisions.[1] This can give rise to a structure emphasizing both geographic and product aspects mentioned previously.

The choice of structure is also linked to the method used to control the operations of a subsidiary. Close control can be achieved by having the product or functional divisions of the subsidiary report to the corresponding divisions of the parent. Control using rates of returns and the budget can be achieved by organizing the subsidiary as a profit center with its local management being given control of its divisions.

For a new or existing MNC the addition of a subsidiary is one of the major structural changes. An existing MNC can also add new responsibilities to an existing subsidiary. The decision process concerning expansion or diversification has already been considered. The items to be considered here are the changes in structure required to accommodate the expansion, and any feedback this will have on the original decision.

---

1. See Caves (1980, p.73).

When a new division is established, lines of communication and authority linking the new division to the existing organization must be established. Accounting, administrative, and budgetary procedures for the new division will be required and the new division must be appropriately staffed. The process of adding a division on a subsidiary to a firm is an acquired skill. A new MNC, having little experience with this, will be in the process of developing the required structures and procedures. An established MNC, however, will have existing structures and procedures that can, possibly with some modification, be applied to a new subsidiary. The need to acquire this skill may delay the initial FDI activity by a firm, but once FDI activity is started it may be expanded at an increasing rate as this skill is acquired.

The organizational structure used by a MNC will tend to change as the MNC expands its operations. It has been noted that a firm setting up its first foreign operations tends to keep these separate from the domestic operations of the parent, due in part to the perceived risks of foreign operations.[1] As the firm's experience with foreign operations increases the perceived degree of risk may decrease.

The choice between setting up a subsidiary de novo and acquiring an existing local firm was considered in Chapter Three and was shown to depend on the costs of each alternative. One of

---

1. Caves (1980, p.73).

the costs depends on the organizational structure and operational procedures of the existing local firm, which may or may not fit in with those of the MNC. In particular, the accounting and budgetary procedures may have to be changed to fit the financial reporting and control techniques used by the MNC, and other changes in procedures may be required to introduce some of the production or marketing skills possessed by the MNC. To make the required changes will involve managerial time and other costs, but these will be smaller the closer the local firm fits the pattern the MNC wishes to achieve.

A specific illustration of how a MNC may change its structure as it grows is found in Robbins and Stobaugh (1974, pp.37-42). They consider changes in the structure relating to financial control. For a small MNC with one or a few subsidiaries the financial staff of the parent will receive reports on the financial activities of the subsidiary but the financial staff of the subsidiary will make their own decisions. For medium sized MNC's where foreign operations are larger, more important, and have a greater effect on the consolidated financial reports of the overall MNC a need for tighter control will be felt. Some sort of shock, such as severe losses on foreign operations, may be required before the need for control will be noticed. To achieve this control an increased financial staff at the parent will make all the major financial decisions and a small financial staff at each subsidiary will implement the decisions concerning that subsidiary. This also allows for better use of the financial flows between the

parts of the MNC to reduce tax liabilities and to take advantage of interest rate differences to reduce the costs of borrowing.

As the MNC continues to expand, increasing the number of subsidiaries and the complexity of its financial operations, it becomes impossible for the financial staff at the head office to make all of the financial decisions for the overall MNC. At this stage more authority to make financial decisions is given to the subsidiaries, but rules and procedures under which these are to be made are established by the head office. The transition from the second to the third phase of financial structure and control may be more gradual than the transition from the first to the second phase.

The structure of financial control in large MNC's may exhibit considerable variation. If the MNC has its foreign operations organized into geographical divisions the head office of each division may have a financial staff with tight control over the subsidiaries in that division, while transactions between geographic divisions will be subject to the rules and procedures established by the financial division of the parent firm. This discussion illustrates that MNC's are not static organizations, but have to change their structure and methods of operation in order to accommodate any expansion they wish to undertake.

4.5   STRUCTURE AND OPERATIONAL DECISIONS

A distinction between strategic and operating decisions has been made and the operating decisions remain to be

discussed, including the assignment of decision-making authority and the procedures used to control those decisions. This distribution of authority, which is due to the limitations imposed by bounded rationality, constitutes part of the structure of the firm.

The management at each level of a firm wants to ensure that the decisions made at a lower level contribute to the objectives established at its own level. For intermediate levels the objectives depend on the objectives and instructions given from higher levels but are made more specific and detailed when they are applied to the particular division or department of the firm. In being made more specific the objectives may be modified to suit the specific interests of the intermediate level management. The problem of management is to delegate the work involved in making decisions to lower levels, while retaining sufficient control to ensure that the decisions made are appropriate to the objectives of the firm. The delegation of such authority is one of the methods used to allow the firm to expand in the face of bounded rationality.

Two methods by which the head office can control the activities of the divisions or subsidiaries were considered in the previous section of this chapter. These are: looking at rates of return on investment; and the use of budgets. The process of expansion and diversification of firms described in this chapter gives rise to one incentive on divisional managements to strive for the objectives of the head office management. Where profits are the objective of the head office management under seeking behaviour,

with divisions organized as profit centers, the management of a division will have an incentive to produce profits in order for their division to be favoured for expansion and to avoid the possibility of their division being cut back in order to obtain funds for use in other areas of the firm. Similar reasoning can be applied to other objectives.

One type of control that can be applied at all levels is the use of procedures and rules of operation in order to limit the range of action open to the managers at the lower level. For such procedures to be useful they must allow for most of the possible circumstances and situations that can arise. The revision of the procedures to keep up with changing circumstances will be an important activity. The amount of effort required to establish the procedures must be substantially less than that required to make the individual decisions. Having standardized procedures that can be applied to all divisions will help in this.

Individual types of decisions and the level to which they are assigned in the firm can be considered. This assignment depends in part on: the type and size of the firm; the type of competition, in particular the degree of oligopolistic reaction expected; and the costs of transmitting information and decisions between the different parts of the firm, where this is partly determined by its structure. Instead of considering the distribution of decision-making authority for a number of types of decisions or a number of firms, one type of decision will be

considered in detail in order to illustrate some of the points involved. The one used is the pricing decisions of a manufacturing firm in an oligopolistic industry.

There are a number of different types of prices that must be set by a MNC: prices on goods which are sold to external customers but are not traded within the MNC; prices on intermediate goods that are traded within the MNC but are not sold to external customers; prices on goods that are both traded internally and sold to external customers; prices on services traded within the MNC, such as fees for management services, for research and development, and for technology; and prices, interest rates, on funds loaned from one part of the MNC to another.

The prices set by the MNC have two affects: prices to external customers effect the level of sales and the revenue of the MNC; and prices on internal transactions, where these take place across international boundaries, effect the tariffs and other taxes payable by the MNC.

There have been a number of different explanations of how prices are set. One that is consistent with the limited information and bounded rationality assumed in this chapter is some form of cost-plus pricing, which a number of authors have suggested is the type of pricing technique used by oligopolists. It will therefore be used to illustrate the allocation of authority to make pricing decisions, without making any claim that it is the only pricing scheme that could be used.

Before considering the operation of this pricing
scheme the constraints on the prices set by the MNC will be noted.
Prices on internal transactions that take place in one country are
unconstrained as they have no direct on revenue or on taxes payable.
Prices on internal transactions that cross international boundaries,
referred to as transfer prices, have implications for tariffs and
profit taxes payable and will be subject to some control by the
appropriate customs and income tax authorities.   Certain limits have
been suggested, one of these being that the MNC would probably not
try to declare the value of its exports to be less than the marginal
costs of production or greater than their market price in the
exporting country.[1]   One standard that tax authorities have used
is that transfer prices should approximate to the prices that would
apply in transactions between separate independent firms.[2]   While
there are difficulties in enforcing these limits they still impose
some limitation on the MNC's freedom of action.   In an oligopoly
setting there are limits on prices charged to external customers.
Prices that are substantially above those charged by competitors
will result in a loss of sales while attempting to charge prices
that are substantially below those charged by competitors may result
in retailiatory price cuts.   Cost-plus pricing was developed to
apply in such a situation and would provide a common method of
determining prices and of working out any price adjustments.

---

1.   Horst (1971, p.1061).
2.   Kopits (1976, p.655).

For a decentralized pricing system to work, the divisions or subsidiaries of the firm must be able to make appropriate decisions under procedures established by the head office. For cost-plus pricing there will be two parts to these procedures. The first will be those of cost accounting, which partly depend on the accounting standards of the home country. The second will be the procedures used to determine the "plus" part, and these will be internal to the firm. In addition, where shipments of components between divisions of the firm are involved the procedures must allow the prices of one division to be used as costs by the other division. Also, the head office must be able to vary the prices set by individual divisions by changing the procedures given to the division while not setting any prices itself.

Under cost-plus pricing the use of standardized cost accounting procedures across all divisions of the firm combined with appropriate procedures for determining the "plus" component will meet these requirements, and should result in transfer prices that usually fall within any limits set by customs and tax authorities. The simplest procedures for calculating the plus part of any price would be for each division to use a specified percentage of the costs incurred in that division. These costs would include any costs paid by that division on external markets, for labour, services, and material inputs purchase from external suppliers, but would exclude any amounts paid for components or services received from other divisions of the MNC. Thus, the

mark-up would be added in stages by each division according to a percentage specified by the head office. This percentage could differ for different types of products or for different divisions.

With this pricing structure the head office of a MNC can use transfer prices to move profits from one subsidiary to the parent or to another subsidiary. The first subsidiary would be instructed to use a reduced or zero percentage when calculating the mark-up to be included in any transfer price charged to other parts of the MNC. The receiving subsidiaries would be instructed to add a mark-up to those prices as well as to the costs they normally consider.

Some prices would be exceptions to the above procedures. For a MNC, head office charges, such as fees for management services or for research and development, are particularly useful for shifting profits. They are more difficult to cost and therefore more difficult for tax and customs authorities to control. Thus, they will be under the direct control of the head office financial section so they can be used to the best advantage of the MNC.

The above discussion is intended to illustrate that the MNC can establish an allocation of authority to make operational decisions subject to procedures established by the head office that satisfy two criteria: the making of individual decisions, including the time and other costs involved, is the responsibility of the individual divisions and subsidiaries; and the head office can

vary the decisions made by changing the procedures and instructions given to the divisions and subsidiaries. Also, the procedures can be standardized for all subsidiaries, thus reducing the effort required to establish and maintain the procedures.

This chapter has presented a model of the process by which firms expand and diversify and has related this to the FDI decisions of MNC's. This process is based on expansion into areas related to the commercial activities and related functions already carried out by the firm, using the skills and abilities that the firm has already acquired. This gives rise to a pattern of expansion which starts with related markets at home then moves to related foreign markets, initially by exporting and then by FDI. This pattern is shown to be consistent with, and to explain, the evidence on FDI presented in section 3.2. The pattern also adds to the explanation of the reasons for FDI.

Chapter Five

S T A T I C   M O D E L S   O F   T H E

M U L T I N A T I O N A L

C O R P O R A T I O N

Chapter Five

STATIC MODELS OF THE MULTINATIONAL
CORPORATION

In the preceding chapters the reasons for FDI and the process by which FDI is undertaken have been considered. The next stage in the thesis is to consider the operations of existing MNC's and how they respond to changes in their environment. No single theory covers all of this and one approach that has been used is comparative static modelling of a profit maximizing MNC. The changes in the environment considered include changes in rates of profit tax and tariffs on imports, as these are items of government policy. The responses include changes in the level of production in the home and host countries and in the level of trade between these countries that the MNC undertakes.

This chapter reviews the comparative static profit maximization models of the MNC that are in the literature, by developing a model that is general enough to include many of these models as special cases. Using this model, it will be shown that the results obtained are particularly sensitive to the assumptions used, thus accounting for some of the differences in the results observed in the existing literature. From this follow certain

121

limitations on the interpretation of the results of the models when policy implications are being considered. These limitations arise because a policy change will affect a number of MNC's and the description of them may involve more than one set of assumptions, thus leading to more than one set of results, and these results may tend to be offsetting at an aggregate level.

The models being considered here have, in general, been based on revenue and cost functions for the firm in each country in which it operates, and on trade between the different parts of the firm. The comparative static profit maximizing models of the MNC that have been developed can be divided into two categories: those that look at a vertically integrated firm, where the different levels of production may take place in different countries, referred to as "the vertical integration models", and those that look at a firm that is engaged in only one level of production, referred to as "the one level of production models". The one level of production models have generally been two-country models and the vertical integration models have generally been three-country models with each of the two stages of production taking place in separate countries, although one model was a two-country model with both stages of production in one country and only the final stage of production in the other country.[1] This limitation to two- or three-country models has been used in

---

1. The vertical integration models can be considered to have started with Copithorne (1971) and the one level of production models with Horst (1971), as a number of more recent articles were based on or were extensions of either one or the other of these articles.

122

order to simplify the mathematical analysis, and is particularly important when the second-order conditions and the comparative statics are considered.[1] The expansion of the model to include more countries and more trade connections between the different parts of the MNC can lead to the comparative statics results being indeterminate.

The mathematical model developed is a version of the two-country vertical integration model developed by Itagaki (1979) that has the final good produced in both countries and the intermediate good produced in one country. It allows for trade by the MNC in both the final and the intermediate good and thus, in terms of the MNC modelled, is as general as any of the models in the articles being considered. In allowing for a single country that exports both the final and the intermediate good instead of just one or the other, the model developed here is more general than any of those being reviewed. Two of the articles extended the model in other directions, one by considering the firms that were competing with the MNC and the other by putting the MNC in an international trade theory setting.[2]

---

1.   Copithorne (1971, p.337) developed, but did not present in detail, more complex models in order to check the results of the three-country model. He found that, "the only apparent effect was to increase the number of degrees of freedom at the disposal of the international corporation", and profits could be shifted while the government's wishes on the setting of transfer prices on major products could be met.
2.   These are Adler and Stevens (1974) and Batra and Ramachandran (1980) respectively.

The models of the MNC considered here, including the version developed, are special or limited cases. Most MNC's have more than one or two subsidiaries, as noted in section 2.2 where the distinction between small, medium, and large MNC's was considered. Also, most MNC's have a range of products, not just a single product. While single product models can be applied to individual products of a multi-product MNC they do not extend to aggregate values over groups of products (see section 2.2) and they do not include the case of joint production. In addition, vertical integration may involve more than two stages of production. This allows components to be exported from one country, further processed, and then reimported to the original country, a situation not allowed for by the models considered here.

The models considered here were developed to extend microeconomic theory to cover the MNC, and to consider the following types of questions about the MNC.

(1) What are the determinants of transfer prices, and does an optimal transfer price for the MNC exist?

(2) What are the effects of the introduction of, or changes in, the rates of, various types of taxes on any or all of the following; transfer prices, local production, local prices, or exports?

(3) What is the effect of reciprocal tariff reductions?

(4) What determines the level of production and the price level in each country?

(5) And, is there a trade-off for the parent firm between exporting or satisfying a foreign market by local production by the subsidiary, and if so what is it?

As stated these questions are not mutually exclusive. The types of taxes referred to in the questions and included in the various models will be discussed later. Question 1 has been, in some form or other, considered in most of the works, as has question 2 for profit taxes and tariffs. The other questions have only been considered in some of the articles.

5.1   ASSUMPTIONS USED

A first step in considering the models is to consider the assumptions used, noting any differences between the various articles, and any differences in the results due to differences in the assumptions used. The embodiment of the assumptions in the mathematical models, and any additional implicit assumptions involved in the mathematics, are also considered.

The theories being considered have assumed that the objective of the MNC is to maximize its global after-tax profits. This assumption is distinct from an assumption that the profits of each of the firms that comprise the MNC are to be maximized separately and the two assumptions will give different results. The first assumption is preferred because it is consistent with the definition of the MNC, where the parent firm has overall control. The use of a profit maximization assumption has usually not been justified in these works, as it is a standard assumption of the theory that the authors were concerned with extending to a multinational setting. The range of assumptions that could be

used and the reason for using profit maximization are discussed in section 2.3, concerned with the objectives of the MNC.

Certain assumptions have been used by all of the models. The assumption, standard to much microeconomic theory, of full and perfect knowledge of all relevant prices and technologies is used. Also, exchange rates are assumed to be fixed and to be known with certainty and unrestricted currency transfers are assumed to be allowed. The theories have also assumed that the products sold on the two final goods markets are identical goods, with the exception of Adler and Stevens (1974) who allow for differentiated products.

The additional assumptions used are not constant across all of the works being reviewed. In some cases the assumptions are alternatives and in other cases the assumptions impose restrictions on the behaviour of the MNC that are not included in other models. The existence of alternative assumptions makes it difficult to develop a fully generalized model and in some cases a choice of assumptions must be made. The importance of the alternative assumptions will be considered when the results of the models are considered.

Assumptions concerning the percentage of the subsidiaries that are owned by the parent firm of the MNC are required. Most of the works have assumed one hundred per cent ownership, although Copithorne (1971) also considered joint ventures. The mathematical model presented will assume that the

126

parent firm owns one hundred per cent of its subsidiary and will also assume that all finance is equity finance. The use of joint venture subsidiaries imposes some restrictions on the MNC and questions about the percentage of ownership of subsidiaries and the use of debt and equity financing are better handled by theory of finance type models than by the models being considered here. The presence of outside shareholders of part of the subsidiary will limit the use of transfer prices to shift profits and cause dividends to be the main method of paying profits to owners. The use of transfer prices to 'shift profits would have the effect of shifting profits from the other shareholders to the parent of the MNC, and would thus be opposed by the outside shareholders.

Models have frequently, but not always, been set up in such a way that it is not necessary to specify which firm is the parent firm of the MNC. · This, in part, involved assumptions about the structure of profit taxes in all countries and about the tax credits allowed in the home country. Many of the articles have assumed that the home country tax rate and the effect of the credits allowed for foreign taxes paid by the subsidiaries can be combined into a single effective rate of tax. Under this assumption the way in which the profit tax variables are included in the model will involve some implicit assumptions about the types of tax credits allowed by the home country. This was discussed by Batra and Hadar (1979). Where separate profit taxes are included for each country, as in Horst (1971), the home country rate must be lower

than the host country rate, if the model is to correctly reflect
a tax credit that is restricted to the lesser of the foreign
taxes paid and the domestic taxes that would have been payable on
the same level of income.   If all profits are taxed at the home
country rate, as in Batra and Hadar (1979), the home country rate
must be higher than the host country rate to reflect correctly
the tax credits and the taxes payable.   Since corporate profit
tax rates are similar in most countries there is no strong argument
in favour of either alternative assumption.   The only way to
avoid making some such assumption is to include a much more detailed
tax structure in the model.

In describing the market structure that the MNC faces
in the countries in which it has operations, the theories have
not given consideration to the competition it faces from other
firms.[1]   Two main assumptions have been used to do this;   it is
either explicitly or implicitly assumed that the MNC is a
monopolist, or it is assumed that some form of imperfect competi-
tion theory that provides a downward sloping demand curve can be
used and no further mention is made of the competitors to the MNC.
This allows the use of a downward sloping demand curve so that
marginal revenue is variable, depending upon quantity sold, and
is not an external parameter to the firm.   The mathematical model
presented will assume that the MNC is a monopolist in all of the
countries in which it operates.   Oligopoly models have been
avoided because, even for a one-country setting, oligopoly theory

---

1.   An exception to this is Adler and Stevens (1974) which is
     discussed later.

128

is in an unsettled state and more precise results can be obtained by using a model where the reactions of other firms in the industry do not enter the model. By avoiding the problems of oligopoly, more emphasis is put on the questions that arise from a multinational setting. Some works on MNC's have considered the oligopoly aspects, but these have not been based on the microeconomic theory approach being considered in this chapter. Some mention of oligopoly considerations has been given in Chapters Three and Four of the thesis.

In addition to assumptions about demand conditions, assumptions about cost conditions are required for the models. Two alternative ways of proceeding are to make assumptions about the shape of the cost curves or to use the stability conditions of the model to determine restrictions on the shape of the cost curves. Both of these alternatives have been used and a variety of different cost curves can be assumed. One alternative is to assume that the average cost curves have the U-shape that is frequently assumed in microeconomic theory. From the second-order conditions it turns out that the existence of increasing or decreasing costs is important. Horst (1971) has shown that with decreasing costs the MNC either becomes a one-country firm that serves the second market by exports, or produces in both countries but does not engage in international trade between the two countries. Increasing costs in each country are required if the MNC is to produce in all countries and engage in international trade. When the mathematical

model is presented this point will be given further consideration. This result applies only to a single product. It also applies to each of the products in a group but, as noted in section 2.2, will not apply to aggregate measures of a group of products.

In developing a vertical integration model some assumption concerning how much of the intermediate good is required to produce a given amount of the final good is required. It has usually been assumed that the intermediate good is used in fixed proportions so that the requirement does not depend on the level of production. Some of the articles have assumed proportions of one to one, by assuming a suitable definition of the units of each commodity. The model presented will use the assumption of fixed proportions but will not require that they be one to one.

All of the models allowed for international trade by the MNC in the commodity it produces but they make different assumptions about trade in this commodity by third parties. The vertical integration models have assumed that arbitrage in the final good sold by the MNC is not possible so the MNC can maintain any price difference it wants between the two markets. As the intermediate good is sold only to other parts of the MNC arbitrage by third parties does not arise. The alternative is to assume that third parties can trade in the good sold by the MNC and this puts a limit on the difference between the prices in the two countries and the limit is a function of the tariffs imposed on imports by the two countries. Which assumption is most reasonable depends on how much control the MNC has over the marketing of its

particular product. Copithorne (1971) used an example of farm machinery where dealers in the low price country were forbidden to sell for export. For other types of markets firms do not have sufficient control over final marketing to prevent exporting from a low-price country. To allow for arbitrage by third parties an explicit price difference constraint must be included in the mathematical model.

Some of the models have also made assumptions about the limits on either, or both, of transfer prices and the minimum level of profits declared in each country. The assumption of a minimum profit constraint is justified by the argument that local tax authorities would not accept losses for a subsidiary if the MNC is making substantial global profits. An alternative assumption is that if customs and tax authorities in each country were reasonably diligent, transfer prices could not be less than the marginal cost of production in the exporting country and could not be greater than the market price in the exporting country.[1] Assuming limits on the profits declared in each country could be inconsistent with a transfer price limitation in certain situations. Both of these types of limitations are reasonable, and which is the most appropriate depends to some extent on the type of industry being considered. The transfer price limitation will be considered in more detail later.

Most of the models of the MNC considered here have included corporate profit tax functions and tariffs on imports.

---

1. This is used by Horst (1971, p.1061).

When taxes were considered the tax rates were allowed to vary between countries and the effects of introducing various taxes or of changing the tax rates were frequently considered. Additional taxes have been considered by some authors. Copithorne (1971) considered sales taxes and excise taxes. Horst (1977), in order to consider the possible effects of certain changes in the United States tax policy towards the parent firms of MNC's, developed a very specific and detailed tax structure. This included: home and host country profit taxes; host country taxes on interest, dividends, and head office charges paid to the parent firm; and home country (United States) tax credits allowed for foreign taxes paid by the MNC.

The mathematical model presented is a two-country vertical integration model with one final good and one intermediate good. As mentioned previously it is assumed that the intermediate good is used in a fixed proportion in the production of the final good, that the exchange rate is fixed and known with certainty, and that the MNC is a monopolist in the final good in both markets and faces downward sloping demand curves. It is also assumed that the MNC produces the intermediate good in the quantity it requires and that there is no market on which the intermediate good can be purchased or sold.

There are a number of additional assumptions that must be made, either explicitly or implicitly, when a mathematical model is set down. The assumptions that have been used, and variations in them, are discussed below.

In the model set out the MNC produces both the intermediate and the final good in country 1 and produces only the final good in country 2, importing the intermediate good from country 1. The model also includes exports of the final good from country 1 to country 2. This structure is used to include both two-country final good production with trade, which is typical of the one level of production model, and two levels of production with trade in the intermediate good which is typical of the vertical integration models. It should be noted that both the final and the intermediate good are exported from the same country. To have country 1 export the intermediate good while importing the final good would require that some of the trade terms in the model be changed.

The model does not specify a specific country as the home country for the firm. . Instead, the effects of each country in turn being the home country are considered, with the assumptions about relative profit taxes rates being specified in each case.[1] Changing which country is the home country has the effect of changing the direction of trade and can influence the interpretation of the results of the model. The effects of changes in the relative profit tax rated, whose importance was discussed by Batra and Hadar (1979), will be discussed as per Itagaki (1979).

The initial model includes separate profit tax rates for each country. When the results are presented both the separate

---

1. Considering each part of the MNC as the parent follows Copithorne (1971).

tax rate and the single tax rate cases are considered. This is
done by substituting in one tax term for both in the results.
From some of the results to be developed determinate results will
only be obtained in the single tax rate case and not in the
separate tax rates case. This occurs because in the former case
it will sometimes be possible to divide out all of the tax terms
in the result while this is usually not possible in the latter case.

In considering the limits on transfer prices a number
of assumptions have been made. The model being developed
includes two transfer prices, one for the final good and one for
the intermediate good. Many of the models being considered
include only one transfer price but any assumption used can be
easily extended to cover both transfer prices. One alternative is
to assume that there are no restrictions of the transfer price
and this was used by Copithorne (1971). Another alternative is
to assume that income tax authorities and customs authorities in
both the importing and exporting countries will try to restrict the
choice of transfer price in order to avoid a loss of revenue. This
was used by both Horst (1971) and Itagaki (1979). Horst (1971,
p.1061) assumed that "a firm would probably not try to declare the
value of its exports to be less than their marginal cost of prod-
uction or greater than their market price in the exporting country",
where this applied to a final good. Itagaki only required a lower
bound for his model and assumed that the transfer price would have
to be greater than, and not equal to, the marginal cost of

production.   The distinction between being strictly greater

than, as compared to equal to, the lower bound will turn out to

be important.   Some of the comparative static results are non-zero

in the former case and zero in the latter case.

There is another lower bound that a case can be made

for, and for the model being developed it will turn out to be

important.   The lower bound could be the average cost and not the

marginal cost of production.   The effect of such a lower bound has

not been considered in the literature.   Marginal cost is difficult

to determine especially for someone outside the firm, and

average cost is easier to determine.   Thus, tax and customs

authorities may be persuaded to accept an average cost figure.

In the model developed, and in the models reviewed, increasing

marginal cost is assumed or may be required by the second order

conditions.   The cases where decreasing costs or constant costs

are allowable are limited and will be discussed later.   The point

to be made here is that with increasing (or non-constant) marginal

costs the average cost will, except for one point, be different

from the marginal cost.   If average cost is less than marginal cost

the transfer price could be less than the marginal cost.   It will

be shown later that the MNC will frequently want to have its

transfer price at the lowest possible level.   Having the transfer

prices below the marginal cost will change some of the results from

the case where the transfer price is equal to, or is greater than,

the marginal cost.   This will be considered further when the

results are developed.

These assumptions must be slightly modified to fit the final and intermediate goods of a vertically integrated firm. For the intermediate good transfer price the lower bound is either the marginal or average costs of its production and for the final good transfer price the lower bound is either the sum of the marginal cost of processing the final good and the marginal cost of processing the quantity of intermediate good required for one unit of the final good or the sum of the average cost of processing the final good and the average cost of producing the intermediate good. For the final good transfer price the upper bound is its price in the exporting country. For the intermediate good transfer price the upper bound is the final good price in the exporting country less either the marginal cost or the average cost of processing the final good. All of the bounds can be defined either as equalities, where the transfer price can equal the bound, or as inequalities, where the transfer price must be above or below the appropriate boundary.

5.2 STRUCTURE OF THE MATHEMATICAL MODEL

The model starts with equations for the earnings of the MNC in each country.

$$E_1 = (1-\tau_1)\{R_1(Q_1) - C_1(Q_1+N) + \pi N + \beta(\frac{Q_2-N}{\alpha})$$

$$- g(\frac{Q_1+N}{\alpha} + \frac{Q_2-N}{\alpha})\} \tag{1}$$

$$E_2 = (1-\tau_2)\{R_2(Q_2) - C_2(Q_2-N) - (1+T_2)\frac{\pi}{e}N$$

$$- (1+r_2)\frac{\beta}{e}(\frac{Q_2-N}{\alpha})\}$$ (2)

The total earnings are given by,

$$E = E_1 + e_2E_2$$ (3)

where

R = revenue from the sale of the final good and = P.Q

C = cost of processing the final good

Q = quantity of the final good sold

N = quantity of the final good exported from country 1 to country 2

π = the transfer price on the final good, in currency 1

α = the proportion in which the intermediate good is required to produce the final good, thus

  (Q$\pm$N)/α = a quantity of the intermediate good

β = the transfer price on the intermediate good, in currency 1

g = the cost of producing the intermediate good

τ = the rate of profit taxes

T = the rate of tariff on imports of the final good

r = the rate of tariff on the intermediate good

e = the exchange rate

It should be noted that in order to use only one set of notation the above symbols are used when any article is being discussed. The original articles have used a variety of symbols and some articles have given different meanings to some of the above symbols.

137

The equation for E is easier to interpret if it is rearranged to the following.

$$E = (1-\tau_1)\{R_1(Q_1) - C_1(Q_1+N) - g((Q_1+N)/\alpha+(Q_2-N/\alpha)\}$$

$$+ e(1-\tau_2)\{R_2(Q_2) - C_2(Q_2-N)\} \quad\quad (4)$$

$$+ \{(\tau_2-\tau_1) - (1-\tau_2)T_2\}\pi N$$

$$+ \{(\tau_2-\tau_1) - (1-\tau_2)r_2\}\beta\{(Q_2-N)/\alpha\}$$

The last two terms of equation (4) can be re-written as,

$$\{(1-\tau_1) - (1-\tau_2)(1+T_2)\}\pi N$$

$$+ \{(1-\tau_1) - (1-\tau_2)(1+r_2)\}\beta\{(Q_2-N)/\alpha\}$$

Also note that,

$$g\{(Q_1+N)/\alpha+(Q_2-N)/\alpha\} = g\{(Q_1+Q_2)/\alpha\}$$

The first order conditions for a maximum are as follows.

$$\frac{\partial E}{\partial Q_1} = (1-\tau_1)\left(\frac{\partial R_1}{\partial Q_1} - \frac{\partial C_1}{\partial Q_1} - \frac{\partial g}{\partial Q_1}\right) = 0 \quad\quad (5)$$

$$\frac{\partial E}{\partial Q_2} = (1-\tau_1)\left(-\frac{\partial g}{\partial Q_2}\right) + e(1-\tau_2)\left(\frac{\partial R_2}{\partial Q_2} - \frac{\partial C_2}{\partial Q_2}\right) \quad\quad (6)$$

$$+ \{(\tau_2-\tau_1) - (1-\tau_2)r_2\}\frac{\beta}{\alpha} = 0$$

$$\frac{\partial E}{\partial N} = (1-\tau_1)\left(-\frac{\partial C_1}{\partial N}\right) + e(1-\tau_2)\left(+\frac{\partial C_2}{\partial N}\right) \quad\quad (7)$$

$$+ \{(\tau_2-\tau_1) - (1-\tau_2)T_2\}\pi$$

$$+ \{(\tau_2-\tau_1) - (1-\tau_2)r_2\}\beta\frac{(-1)}{\alpha} = 0$$

In deriving equation (7) the terms

$$\{(\tau_2 - \tau_1) - (1-\tau_2)T_2\} \frac{\partial \pi}{\partial N} N$$

and

$$\{(\tau_2 - \tau_1) - (1-\tau_2)r_2\} \frac{\partial \beta}{\partial N} (\frac{Q_2 - N}{\alpha})$$

have been ignored as being of the second order of smallness. This follows Horst (1971) and Itagaki (1979). These terms indicate the effects of any change in the limits to the transfer price that result from a change in the level of exports.

The transfer price limits, when based on marginal costs, can be expressed mathematically as specified below.

Table 5.1   -   Transfer Price Limits

transfer price	lower bound	upper bound
π	$\frac{\partial C_1}{\partial Q_1} + \frac{\partial g}{\partial Q_i}$	P_1
$\frac{\beta}{\alpha}$	$\frac{\partial g}{\partial Q_i}$	$P_1 - \frac{\partial C_1}{\partial Q_1}$

P = the price of the final good. As noted previously, the transfer price limits can be either equalities or inequalities.

5.3   RESULTS   OF   THE   MODEL

The model produces a number of results. The first to be considered is the choice of the transfer prices. This can be determined from equation (4) and for the final good transfer price, involves the maximization of the term $((\tau_2 - \tau_1) - (1-\tau_2)T_2)$.

If country 2 is the home country and $\tau_2 < \tau_1$ it can be seen that the term will always be negative, and the MNC will choose the minimum possible transfer price, which could be zero if no higher minimum is imposed. If $\tau_1 < \tau_2$ then, to reflect the tax credit τ_2 should be substituted for τ_1 and the expression becomes $(-(1-\tau_2)T_2)$ which will always be negative, so the minimum transfer price will be chosen. This corresponds to the results obtained by Itagaki (1979). To obtain the results obtained by Horst (1971) the case where country 1 is the home country must be considered. If $\tau_1 < \tau_2$ the term $((\tau_2-\tau_1) - (1-\tau_2)T_2)$ can be either positive or negative. By rearranging, by dividing through by $(1-\tau_2)$, the relative profit tax differential can be compared to the tariff. This gives $(\tau_2-\tau_1)/(1-\tau_2) \lessgtr T_2$. If the "less than" inequality holds the MNC will choose the minimum transfer price but if the inequality is reversed the MNC will choose the maximum transfer price, paying more in tariffs but saving on the high taxes of the importing country. If the home country tax rate is higher than the host country rate the reduced expression is again always negative and the minimum transfer price is chosen. The choice of the transfer price on the intermediate good depends on the term $((\tau_2-\tau_1) - (1-\tau_2)r_2)$, since $(Q_2 - N)$ is always positive. Thus, the reasoning and results are the same as given above.

These results show that the assumption about the direction of trade, from the home country to the host country or the reverse, can affect the results obtained.

Transfer prices are indeterminate if there are no taxes, as was shown by Copithorne (1971), unless the firm has a desired distribution of profits. This holds for the model presented here. If there are no taxes, the limits on transfer prices serve no purpose and the option of assuming only a lower bound of zero, used by Copithorne (1971), becomes reasonable.

The interpretation of the first-order conditions is done first with the tax terms excluded and then with them included.[1] Equation (5) gives

$$MR_1 = MC_{1F} + MC_I \tag{8}$$

where MC_{1F} and MC_I are the marginal costs of processing the final good and the intermediate good, and MR is the marginal revenue. This holds whether or not the taxes are included and says that in the exporting country the marginal revenue will equal the sum of the marginal costs.

In the no tax case, with the exchange rate equal to one, equations (6) and (7) give,

$$MR_2 = MC_{2F} + MC_I \tag{9}$$

and

$$MC_{1F} = MC_{2F} \tag{10}$$

From this it follows that the marginal cost totals will be equal in both countries and that the marginal revenues will be equal. This condition will be obtained by the MNC by adjusting the amount

---

1. This follows Copithorne (1971).

of the final good traded.   Copithorne (1971) obtained the same

conditions for the relation of the marginal revenues to the marginal

costs, but because he did not include trade in the final good did

not obtain a condition requiring an equality of the marginal costs

of processing the final good nor an equality of the marginal

revenues.   He obtained a weaker condition.   Specifically,

$$(MR_1 - MC_{1F}) = (MR_2 - MC_{2F}) = MC_I.$$

Where the tax variables, the exchange rate, and both

tax rates are retained, equations (6) and (7) give,

$$MR_2 = MC_{2F} + \frac{(1-\tau_1)}{e(1-\tau_2)} MC_I - \frac{((\tau_2-\tau_1) - (1-\tau_2)r_2)}{e(1-\tau_2)} \frac{\beta}{\alpha} \tag{11}$$

and

$$MC_{2F} = \frac{(1-\tau_1)}{e(1-\tau_2)} MC_{1F} - \frac{((\tau_2-\tau_1) - (1-\tau_2)T_2)\pi}{e(1-\tau_2)} \tag{12}$$

$$-\frac{((\tau_2-\tau_1) - (1-\tau_2)r_2)}{e(1-\tau_2)} \cdot \frac{\beta(-1)}{\alpha}$$

These two expressions can be arranged as per Horst

(1971) to make the interpretation clearer.

$$MR_2 = MC_{2F} + \frac{1}{e}MC_I + \frac{1}{e}r_2 \frac{\beta}{\alpha} - \frac{(\tau_2-\tau_1)}{e(1-\tau_2)}(\frac{\beta}{\alpha} - MC_I) \tag{13}$$

$$MC_{2F} = \frac{1}{e} MC_{1F} + \frac{1}{e} (T_2\pi + r_2\frac{\beta(-1)}{\alpha}) \tag{14}$$

$$-\frac{(\tau_2-\tau_1)}{e(1-\tau_2)} (+ \frac{\beta(-1)}{\alpha} - MC_{1F})$$

When the home country profit tax rate exceeds the host country rate

the assumptions concerning the tax credit require that the home

country rate be applied to all income, and after the resulting

substitution conditions (13) and (14) lose their final term as $(\tau_2 - \tau_1)/(e(1-\tau_2)) = 0$ when one tax rate appears throughout.

Condition (13) states that the marginal revenue in country 2 is equal to the sum of the marginal cost of processing the final good in country 2 plus the marginal cost of importing the required intermediate good from country 1. The marginal cost of importing includes the marginal cost of processing the intermediate good, adjusted so all values are in the same currency units, plus the tariff costs on the quantity required to produce a unit of the final good, less any tax saving in the exporting country.

Condition (14) equates the marginal cost of processing the final good in the importing country to the marginal cost of importing the final good from the exporting country. The importing costs equal the marginal cost of production, adjusted to be in the same currency, plus the unit tariff cost, less any tax advantage to producing in the exporting country. These two results correspond to those obtained by Horst (1971, p.1063). When there is only one tax rate in the model the tax advantage becomes equal to zero.

The second-order conditions must also be considered. These are specified in the Appendix as equations (A2) to (A6). These conditions require that the marginal revenue for the final good in each country be decreasing and the marginal costs of the final good in each country, and of the intermediate good, be increasing. With the imposition of two additional conditions,

specified below, decreasing costs for the intermediate good can be allowed for. The initially stated conditions correspond to those obtained by Itagaki (1979), who did not consider the case of decreasing costs for the intermediate good, but conflict with those obtained by Horst (1971), who included only a final good and found that the slope of the marginal cost curve in either country could be negative (decreasing costs) provided that the sum of the two cost curves was positive (increasing costs). Part of the reason for this conflict of results is the inclusion of an intermediate good produced only in one country, which is related to the final good in both countries. This replaces some of the zero elements in the Hessian with non-zero elements. Horst (1971, p.1063) pointed out that if the slope of the sum of the marginal cost curves was negative the firm would either produce everything in one country and serve the other by exports, or would produce in both countries but refuse to export between the two.

For decreasing costs in the production of the intermediate good to be consistent with the second-order conditions the following conditions must be met. The marginal revenue of the final good in each country must decrease faster than the marginal cost of the intermediate good. For each country the sum of the marginal cost of the final good plus the marginal cost of the intermediate good must be increasing. This is explored in the Appendix as equations (A5) and (A6). In deriving any additional results from the model it will be assumed that all costs are increasing.

Copithorne (1971, pp.325-326) did not use the second-order conditions to determine the restrictions on the cost and revenue curves but followed the other option and assumed curves of a conventional shape, specifically decreasing marginal revenue curves for the final product and U-shaped short-run marginal cost curves for both the final and the intermediate good. In this he was followed by Booth and Jensen (1977) and by Eden (1978).

The comparative static results are sensitive to the precise mathematical formulation of the model, and to the assumptions about the relative rates of profit taxes, the transfer price limits, and to the choice of transfer price made by the MNC. Because of this a number of different cases are possible for the model presented here, but results for all of them are not worked out. Results for a sufficient number of cases are worked out to show that they are sensitive to the particular assumptions made. Some of the cases not worked out require additional assumptions about the extent to which transfer prices differ from marginal costs (see equation (A15)), and only one of the possible cases was worked out. Some additional results are reported in the next section where more of the works in the literature are reviewed. The main equation from which the comparative static results are derived is given in the Appendix as equation (A1).

The comparative static results for a change in the profit tax rate in country 1 produce a number of cases. Where both transfer prices are equal to a lower bound that is based on

marginal costs then the comparative statics equations equal zero (see equations (A9), (A10), and (A11)). This says that the quantity of the final good sold in each country and the quantity exported from country 1 does not change, from which it follows that the quantities of the final and intermediate goods produced also do not change. Thus, a change in the profit tax rate of the exporting country has no effect on the production and sales decisions of the MNC. These results are consistent with, but not identical to, those obtained by Horst (1971). Horst looked at the results for a tax difference term $(\tau_2-\tau_1)/(1-\tau_2)$, and results for such a term cannot be obtained from the model presented here, due to the inclusion of the intermediate good.

When the transfer prices are at lower bounds based on marginal costs and defined in terms of inequalities the comparative statics for the above case are no longer zero. Equations (A9), (A12), and (A13) specify the effects of assuming these limits on the various elements of equation (A1). To sign (A13) it is necessary to make assumptions about the relative amount by which each transfer price exceeds its lower bound. These are offsetting in (A13) and were assumed to be equal so that (A13) was set to zero. This was done because any value it has will be less than the amount by which either transfer price exceeds its lower bound. The comparative static results are given by (A16) and are,

$$\frac{\partial Q_1}{\partial \tau_1} > 0, \quad \frac{\partial Q_2}{\partial \tau_1} < 0, \quad \text{and} \quad \frac{\partial N}{\partial \tau_1} < 0$$

146

The first two of these correspond to the results obtained by

Itagaki (1979), but the country subscripts are reversed (1 for 2

and 2 for 1) because the model is set up differently. These

results depend on the retention of two separate profit tax rates

in the model, which depends on the previously discussed assumption

and requires that the home country profit tax rate be less than

the host country rate. When only one tax rate is used throughout

the model the comparative statics equations equal zero. The non-

zero comparative statics equations state that an increase in

the profit tax rate of the exporting country will result in an

increase in sales of the final good in the exporting country, a

decrease in sales of the final good in the importing country, and

a decrease in the quantity exported. If the transfer prices are

less than the marginal costs these comparative statics will be

reversed (see the discussion after equation (A16)). This reversal

was also noted by Itagaki (1979, p.444). These results are

considered further in the next section when Itagaki (1979) is

discussed.

The comparative statics for a change in the profit

tax rate in country 2 are also equal to zero when the transfer

prices equal a lower bound based on marginal costs. When the

lower bound is an inequality the comparative statics are, assuming

(A23) to be zero in the same way as was done for (A13), as follows

(see (A24)),

$$\frac{\partial Q_1}{\partial \tau_2} < 0, \quad \frac{\partial Q_2}{\partial \tau_2} > 0, \quad \text{and} \quad \frac{\partial N}{\partial \tau_2} > 0.$$

These again correspond to the results obtained by Itagaki (1979).

Comparative statics for transfer prices based on an upper bound have not been worked out. These were considered by Horst (1971), and this article is discussed further in the next section.

The comparative static results for an increase in the tariff imposed on imports of the final good by the importing country are as follows, (see (A27)),

$$\frac{\partial Q_1}{\partial T_2} > 0, \quad \frac{\partial Q_2}{\partial T_2} < 0, \quad \text{and} \quad \frac{\partial N}{\partial T_2} < 0$$

The second and third of these correspond to the results obtained by Horst (1971, p.1071). These state that imports will decrease, sales in the importing country will decrease, and sales in the exporting country will increase in response to an increase in the tariff. The effects on production in each country could go in either direction due to the offsetting effects of the changes in sales and in the quantity traded.

The comparative static results for the tariff on the intermediate good are given by (A26) as,

$$\frac{\partial Q_1}{\partial r_2} < 0, \quad \frac{\partial Q_2}{\partial r_2} < 0, \quad \text{and} \quad \frac{\partial N}{\partial r_2} > 0.$$

Eden (1978) in a three-country vertical integration model considered the effects of these types of tariffs and obtained the above results for the tariffs on both the final good and the intermediate good. The results for the tariff on the intermediate good state that an increase in the tariff will increase imports of the final good but

will reduce local sales of, and production of, the final good.
Imports of the intermediate good will decline due to the decrease
in production of the final good.

More results could be produced from the model
presented here and the results could be discussed in more detail.
As this chapter is a review of the literature this is left to
the next section. This section has served to illustrate how the
results change as the assumptions are changed.

5.4   RESULTS OF OTHER MODELS

The model developed here can produce a number of
additional results and can be extended in a number of ways. As
this chapter is a survey of the literature, these results, their
interpretation, and the extensions that have been developed, will
be summarized from the existing literature. This will proceed by
reviewing individual articles in turn.

Before considering these results, a point about the
interpretation of conflicting results obtained from alternative
assumptions will be made. Each version of the model describes a
specific situation and the aggregate real-world policy situation
is likely to be a combination of a number of cases. For example,
for most home countries the profit tax rate is likely to be above
some of the host country rates and below other host country rates.
Thus, the aggregate effect of a tax change on domestic production
will be a weighted combination of zero and non-zero effects with the

relative weights depending on the importance of each type of case in the total. A similar weighted combination of results applies when other factors, such as transfer price limits, can result in multiple cases being possible.

Models developed to consider specific policy questions can be structured to avoid some of the restrictive assumptions that generate multiple cases. This is illustrated by Horst (1977), where a model was developed to consider the possible effects of certain changes in United States tax policy towards the parent firms of MNC's. It included a very specific and detailed tax structure including: profit taxes in both the home and host countries; host country withholding taxes on interest, dividends, and head office charges paid to the parent firm; and a detailed treatment of the tax credit allowed by the United States for foreign taxes paid by the MNC. Horst also allowed for borrowing by the parent and the subsidiary and for the use of intra-firm debt. He was concerned with the effect of changes in the deferral of taxes on income not repatriated as dividends, and found that the current United States tax structure provided an incentive to invest abroad but that the repeal of the tax deferral would remove most of the incentive. The repeal of the tax credit, which would result in double taxation, would encourage debt over equity financing of subsidiaries and would reduce foreign, and in some cases domestic, investment. The model still has limitations, a notable one being the exclusion of trade between the parent and the subsidiary, which is included in many of the other models considered here. Although

only one subsidiary is included, the more detailed tax structure removes the need for assumptions concerning the relative tax rates. The shaping of this model to a specific purpose, and its limitations, further illustrate the difficulty of developing a completely general model.

In considering any results there are two ways in which the countries can be distinguished: the home and the host country; and the importing and the exporting country. The second distinction may not always be precise as a model could be set up where a country exports the intermediate good but imports the final good.

Itagaki (1979) used a model of a vertically integrated two-country MNC where the home country imported the intermediate good and obtained the following results. When the home country profit tax rate is increased home country production and sale of the final good is increased by the MNC and host country production and sale of the final good is decreased.

To explain this result Itagaki goes back to the first order conditions and rearranges them to show a separate gain or loss in each country. Under the assumptions used, at the margin the parent firm will show a loss while the subsidiary shows a gain. Thus a rise in the profit tax rate results in a decrease in the net marginal loss from home sale, which encourages home sale, which in turn requires a decrease in the sale in country 1 for the first order conditions to be met. This change shifts profits from the

home country to the host country, and is shown to raise the
production of the intermediate good in the host country. Itagaki
(1979, pp.443-444) also showed that the tax revenue of the host
country would increase, but the effect on the tax revenue of the
home country could go either way, and that the balance of trade
in goods and services of the home country is adversely affected,
but the increased repatriation of profits has the opposite effect.
An increase in the host country (the exporting country) tax rate
was shown to result in an increase in the production of the final
good in the host country and a decrease in its production in the
home country.

Horst (1971) found that his results depended on
whether the firm had increasing or decreasing costs. This was
considered when the second-order conditions were discussed and it
was shown that in the more general model presented here increasing
costs could only be allowed under specified conditions. In the
decreasing cost case the firm will not mix imports and local
production. The firm will tend to produce in the larger market and
may do so even if costs are higher there, provided the cost difference
is less than the tariff. The effects of tariff changes will be
small unless the firm decides to change its strategy.

Horst (1971) extended his basic model by considering
the case where there is a limit on the differences in the prices
the MNC can charge in the two countries due to arbitrage by third
parties. This limit depends on the tariffs on imports and can be

expressed as

$$T_2 P_1 \geqslant (P_2 - P_1) \geqslant - T_1 P_2$$

Horst went on to derive a condition giving the price difference desired by the MNC and examined the conditions under which this would or would not fall within the range allowed by the constraint. He found that "the higher the level of existing tariffs and the closer the elasticities of demand in the two markets are the more likely it is that independently chosen prices will be sustainable."[1]

Horst also considered the effect on the comparative static results of the price difference constraint being binding on the MNC and found that an increase in tariffs could no longer be counted upon to encourage local production. A change in the rate of profit tax, however, can have a substantial effect, but the effect depends on which country has the higher price, the importing or the exporting country. The decreasing cost case also becomes more complex when prices are constrained.

Copithorne (1971) considered the effects of the existence of, or changes in, the rates of profit taxes, tariffs, sales taxes and excise taxes on the decisions of the MNC. He concluded that pure profit taxes would not affect output, sales, or final prices. This result is partly due to the fact that he did not impose any restrictions on the transfer price or on the difference in the prices of the final good in the two countries

_____

1. Horst (1971, pp.1065-1066).

153

where it is sold. Tariffs, sales taxes, and excise taxes would

effect the choice of transfer prices, which would be used to

minimize the total tax bill, and could also effect output and sales

by affecting the prices of the final good. Copithorne also

concluded that limits on transfer prices may cause the MNC to

engage in additional intra-firm trading in order to have more

degrees of freedom in shifting profits.

The model developed by Copithorne (1971) was

extended in articles by Booth and Jensen (1977) and by Eden (1978).

Booth and Jensen were concerned with determining the conditions

under which transfer prices would be determinate. They assumed

that transfer prices could not be negative, while Copithorne did

not assume this for all of his article. Booth and Jensen obtained

the same profit maximizing condition as Copithorne. They also

found that the minimum profit constraint in each county that the

model included put a bound on the range of transfer prices that the

MNC could use. Also, if transfer prices are at this limit,

changes in the rates of profit taxes can affect the allocation of

output between the countries as transfer prices could not be used

to shift profits. The cases where transfer prices must be non-

discriminatory between countries was considered and the results

obtained depended upon the cost conditions and the shape of the

tax functions.

Eden (1978) allowed for trade between the two

secondary product firms, which Copithorne (1971) did not consider

as a possibility.   Eden also assumed that the transfer price is

fixed and does not change in response to changes in the tax rates.

This was done so the effects on output and trade could be

considered but some comments on how the MNC would like to change

transfer prices were included.   Eden obtained the same profit

maximization conditions as were obtained from the model presented

above, and the directions and types of trade allowed in the two

models are the same.   Eden's comparative static results for

import tariffs have already been considered.   Eden also allowed

the MNC to vary the proportion of dividends remitted by the

subsidiary to the parent, instead of assuming repatriation of all

profits, and found that the MNC would use this in responding to

changes in taxes and tariffs.

Some of the models considered here have included the

effects of changes in the exchange rates and two of these have also

considered the effects of having fluctuating exchange rates instead

of fixed rates.   The comparative statics results obtained depend

on whether the parent exports to, or imports from, its subsidiary.

Where the parent exports the final good to the subsidiary it was

found that a devaluation of the home currency leads to an increase

in home country production, an increase in exports, and a decrease

in production in the host country by the MNC.   This was shown by

Batra and Hadar (1979, pp.262-263) who also found that the MNC

profited from the devaluation as long as its foreign operations were

profitable.   Kohlhagen (1977, p.45) obtained similar results, in

that a devaluation of the home currency caused a reduction in foreign investment by the MNC and an expansion of exports and domestic investment.

Itagaki (1971, pp.445-446) considered the effect of the devaluation of the home country currency when the parent imports an intermediate good from its subsidiary and found that home sales of the final good decrease and that host country sales of it increase. Imports of the intermediate good also decrease. This reversal of results further indicates the importance of the assumptions about the direction of trade.

The case of a fluctuating exchange rate was considered by Batra and Hadar (1979) and by Itagaki (1977). They both assumed that the exchange rate was a non-negative random variable and that the objective of the MNC was to maximize profits or a profit utility function that was a strictly increasing and strictly concave function. Batra and Hadar (1979) included a forward foreign exchange market in their model but Itagaki (1977) did not include such a market. Batra and Hadar also assumed that all profits were repatriated and all foreign exchange was converted to the home currency at the end of each period.

Batra and Hadar (1979, pp.267-269) found that the impact of the fluctuating exchange rates depended on the firm's assumption about the value of the expected exchange rate relative to the forward rate. They concluded that if the firm expects the exchange rate to exceed the forward cost when all marginal costs

are rising then home sales are increased while foreign sales and exports are decreased, and the firm reduces its production at home and increases it in the host country. They also concluded that in the absence of a forward market, the MNC reacts to uncertainty about the exchange rate in the same way as it reacts to a fall in the value of the exchange rate (a devaluation of the home currency) when it is known with certainty.

Itagaki (1977, pp.62-69) considered the case where the subsidiary was making profits and also where it was making losses while Batra and Hadar considered only the first of these. If the subsidiary is making profits the MNC will be a seller of the host country currency and if it is making losses the MNC will be a purchaser of the host country currency. In comparing fixed and flexible exchange rates he assumed that the fixed rate equalled the mean of the flexible rate. When the subsidiary profit is positive, production of both the final and the intermediate good is higher under a flexible than under a fixed exchange rate and intra-firm trade in the intermediate good is also greater. These results are reversed when the subsidiary is making losses. Itagaki (1977, p.89) also compared some of the comparative static results under the two exchange rate regimes. When the home country profit tax rate is greater than or equal to the host country rate, changes in the home tax rate will affect the behaviour of the MNC under a flexible exchange rate but will have no effect under a fixed exchange rate. When the relative profit tax rates are reversed the comparative

157

statics for profit tax and tariff rate changes are indeterminate under a flexible rate but determinate under a fixed rate.

Since the exchange rate regime must be either fixed or flexible this only implies that the appropriate model should be used at any one time. However, when some currencies are fixed relative to each other but flexible against other currencies, such as the currencies of the European Monitary Union, the situation becomes more complex. For MNC's based in those areas with subsidiaries both inside and outside the fixed exchange rate currency area the effect of any tax or tariff change could be a weighting of two different effects depending upon the amount of investment subject to each type of exchange rate.

Horst (1973) extended his 1971 results to include consideration of the development of new technology. The new technology was assumed to make the product more attractive to buyers in both countries and was incorporated in the model by a demand shift parameter. By assuming that the returns to research and development (R and D) are known with certainty Horst was able to derive conditions for the optimal expenditure on R and D and for the distribution of these costs between the two countries. This assumption of certainty is, in the case of R and D, unrealistic and limits the value of the results. The article is useful, however, in indicating that it should be possible to extend the theory of the MNC to consider R and D, which is a significant activity for many MNC's.

Adler and Stevens (1974) modified the basic one level of production model in two ways. They assumed that the good produced by the subsidiary of the MNC could be differentiated from the good produced by the parent firm. They also added a second stage to the model that included competition by local host country firms and exports to the host country by third country firms, each group being represented by a single firm. The host country firm produced an identical good to that produced by the subsidiary of the MNC. The good imported from the third country firm could be a differentiated product. Adler and Stevens solved their extended model numerically using empirical estimates of production and cost functions and using a range of reasonable parameters for the demand functions. This method was used because of certain mathematical complexities in the solution of the full model. Adler and Stevens found that Horst's (1971) results were partly due to his assumption of identical goods being produced and sold in both countries, but they also found that the slopes of the cost and demand functions were still important. In considering export displacement they found that the results are sensitive to the demand parameter measurements and that foreign direct investment usually reduces the exports of the parent firm. The interactions between the MNC and its competitors was also found to be important. This model is limited in that the export of components or inter- mediate goods from the parent to the subsidiary is not included in the model, and the inclusion of these could alter the conclusions on the extent of export displacement.

Batra and Ramachandran (1980) added the MNC to an international trade theory model. Their primary concern was with the effects on international trade theory, which is not a concern of this thesis. Their model included a two-country MNC that could shift production and engage in trade, and was concerned with the effects of tariff and tax changes on production, rates of return on capital, and real wage rates in both countries. Their model is not considered in detail, as that would require the specification of the international trade theory setting they use. The model is noted here to illustrate that there is a considerable range of ways in which a MNC model can be developed.

The models considered in this chapter have a number of limitations. They are static models and some of the authors have stated that dynamic models would be useful.[1] Dynamic models, and the way they extend the model, are considered further in the next chapter. The models are also limited to two or three countries, to one final good, and to one or two levels of production. The restrictions these impose on the interpretation of the results have been discussed, and serve to illustrate the importance of using the correct model and assumptions when considering any specific situation or policy proposal.

_____

1. Copithorne (1971, p.336), Horst (1977, p.376), and Adler and Stevens (1974, p.675).

The objective function and the first order conditions
are given in the main text as equations (1) to (7). To consider
the second order conditions and the comparative static results the
total differentials of the first order conditions are taken and
arranged in matrix notation as equation (A1). This does not,
however, include the terms for changes in the proportion of the
intermediate good used in the production of the final good and in
the exchange rate. The latter is considered in the section
where additional articles are reviewed. Equation (A1) includes
both profit tax terms. If only one profit tax rate is used for
all profit taxes in the model, all the profit tax terms can be
eliminated from the first order conditions, changes in the profit
tax rate will not effect the results of the model, and the comparative
static results for such changes will be zero.

For the second order conditions to be met the Hessian
must be negative definite. To determine the signs of $\left|H_2\right|$ and
$\left|H_3\right|$ it is necessary to multiply out the determinants as assumptions
about the signs of the elements of the matrix do not yield signs for
the determinants. These are specified as equations (A2) and (A3)
below.   For $\left|H_1\right|$ to be negative it is required that,

$$\frac{\partial^2 R_1}{\partial Q_1^{\;2}} - \frac{\partial^2 C_1}{\partial Q_1^{\;2}} - \frac{\partial^2 g}{\partial Q_1^{\;2}} < 0$$

$$
\begin{bmatrix}
(1-\tau_1)\left(\dfrac{\partial^2 R_1}{\partial Q_1^2} - \dfrac{\partial^2 C_1}{\partial Q_1^2} - \dfrac{\partial^2 g}{\partial Q_1^2}\right) & (1-\tau_1)\left(-\dfrac{\partial^2 g}{\partial Q_1 \partial Q_2}\right) & (1-\tau_1)\left(-\dfrac{\partial^2 C_1}{\partial Q_1 \partial N}\right) \\[2em]
(1-\tau_1)\left(-\dfrac{\partial^2 g}{\partial Q_1 \partial Q_2}\right) & (1-\tau_1)\left(-\dfrac{\partial^2 g}{\partial Q_2^2}\right) + e(1-\tau_2)\left(\dfrac{\partial^2 R_2}{\partial Q_2^2}\ \dfrac{\partial^2 C_2}{\partial Q_2^2}\right) & e(1-\tau_2)\left(-\dfrac{\partial^2 C_2}{\partial Q_2 \partial N}\right) \\[2em]
(1-\tau_1)\left(-\dfrac{\partial^2 C_1}{\partial Q_1 \partial N}\right) & e(1-\tau_2)\left(-\dfrac{\partial^2 C_2}{\partial Q_2 \partial N}\right) & (1-\tau_1)\left(-\dfrac{\partial^2 C_1}{\partial N^2}\right) + e(1-\tau_2)\left(-\dfrac{\partial^2 C_2}{\partial N^2}\right)
\end{bmatrix}
\begin{bmatrix} dQ_1 \\[2em] dQ_2 \\[2em] dN \end{bmatrix} =
$$

$$
\begin{bmatrix} + \left(\dfrac{\partial R_1}{\partial Q_1} - \dfrac{\partial C_1}{\partial Q_1} - \dfrac{\partial g}{\partial Q_1}\right) \\[1.5em] - \dfrac{\partial g}{\partial Q_2} + \dfrac{\beta}{\alpha} \\[1.5em] - \dfrac{\partial C_1}{\partial N} + \pi + \dfrac{\beta}{-\alpha} \end{bmatrix} d\tau_1
+
\begin{bmatrix} 0 \\[1.5em] + e\left(\dfrac{\partial R_2}{\partial Q_2} - \dfrac{\partial C_2}{\partial Q_2}\right) - (1 + r_2)\dfrac{\beta}{\alpha} \\[1.5em] + e\left(\dfrac{\partial C_2}{\partial N}\right) - (1 + T_2)\pi - (1 + r_2)\dfrac{\beta}{-\alpha} \end{bmatrix} d\tau_2
+
\begin{bmatrix} 0 \\[1.5em] (1-\tau_2)\dfrac{\beta}{\alpha} \\[1.5em] (1-\tau_2)\dfrac{\beta}{-\alpha} \end{bmatrix} dr_2
+
\begin{bmatrix} 0 \\[1.5em] 0 \\[1.5em] (1-\tau_2)\pi \end{bmatrix} dT_2
$$

$$(A1)$$

In order to have $|H_2| > 0$ and $|H_3| < 0$ it is required that the marginal revenue of the final good in each country be decreasing, and that the marginal costs of processing the final good in each country be increasing. The intermediate good can have either increasing or decreasing costs. To allow for decreasing costs for the intermediate good some additional restrictions are required and these are specified below. From the above conditions, with increasing costs for the intermediate good the elements of the Hessian have the following signs.

$$
\begin{bmatrix}
- & - & - \\
- & - & + \\
- & + & -
\end{bmatrix}
$$

With decreasing costs for the intermediate good this becomes,

$$
\begin{bmatrix}
- & + & - \\
+ & - & + \\
- & + & -
\end{bmatrix}
$$

To show the multiplication of the determinant of the Hessian, where the marginal revenues are decreasing and the marginal costs are increasing, let

$$
-a = (1-\tau_1) \frac{\partial^2 R_1}{\partial Q_1^2}
$$

$$
b = (-\tau_1) \frac{\partial^2 C_1}{\partial Q_1^2} = (1-\tau_1) \frac{\partial^2 C_1}{\partial Q_1 \partial N} = (1-\tau_1) \frac{\partial^2 C_1}{\partial N^2}
$$

$$c = (1-\tau_1) \frac{\partial^2 g}{\partial Q_1^2} = (1-\tau_1) \frac{\partial^2 g}{\partial Q_1 \partial Q_2} = (1-\tau_1) \frac{\partial^2 g}{\partial Q_2^2}$$

$$-d = e(1-\tau_2) \frac{\partial^2 R_2}{\partial Q_2^2}$$

$$f = e(1-\tau_2) \frac{\partial^2 C_2}{\partial Q_2^2} = e(1-\tau_2) \frac{\partial^2 C_2}{\partial N^2}$$

$$-f = e(1-\tau_2) \frac{\partial^2 C_2}{\partial Q_2 \partial N}$$

All the letters themselves are positive, in this case, and the determinant becomes,

$$\begin{vmatrix} -a-b-c & -c & -b \\ -c & -c-d-f & f \\ -b & f & -b-f \end{vmatrix}$$

Multiplying this out and then cancelling all the cases where the same term appears twice, but with opposite signs, gives,

$$|H_3| = -abc\ -acf\ -abd\ -adf\ -abf\ -bdf\ -bcd\ -cdf \qquad (A2)$$

This has the appropriate negative sign. To consider decreasing cost cases later, only these eight terms need to be considered. Multiplying out $|H_2|$ and cancelling terms gives,

$$|H_2| = ac + ad + af + bc + bd + bf + cd + cf \qquad (A3)$$

Since all these terms are positive $|H_2|$ has the required sign.

To consider the case of decreasing costs for the intermediate good c is changed to $-c$, so that the letter itself still represents a positive term. Then $|H_2|$ becomes,

$$|H_2| = -ac + ad + af - bc + bd + bf - cd - cf \qquad (A4)$$

This can be either positive or negative so the second order conditions are not met. For example, it will be negative if $a = 1$, $b = 2$, $c = 1.6$, $d = 1$, and $f = 2$. Imposing additional conditions can make $|H_2|$ positive. Imposing a condition that the sum of the marginal costs of the intermediate good and the final good be increasing is not sufficient. Imposing a condition that the marginal revenue decrease faster than the marginal cost of the intermediate good increases is also not sufficient, but imposing both of these conditions is sufficient. The first of these conditions gives,

$$(b - c) > 0 \qquad \text{and} \qquad (f - c) > 0$$

while the second gives,

$$a > c \qquad \text{and} \qquad d > c \ .$$

Rearranging $|H_2|$ gives,

$$|H_2| = a(-c+f) + b(-c+d) + d(-c+a) + f(-c+b) \qquad (A5)$$

which shows that the above conditions are necessary.

To consider the conditions required for $|H_3|$ to be negative it can be rearranged to,

165

$$|H_3| = ab(c-d) + ae(c-b) + bd(c-f) + df(c-a) \qquad (A6)$$

which shows that the above conditions are sufficient to make it negative.

The comparative static results depend on the assumption about the relative profit tax rates. If the home country rate is lower than the host country rate both rates are included in the model (case 1) and if the home rate is greater than the host rate the home rate is substituted for the host rate (case 2). In case 2 some of the first order conditions are simplified, as noted in the main text, and equations (6) and (7) become,

$$- \frac{\partial g}{\partial Q_2} + e \left(\frac{\partial R_2}{\partial Q_2} - \frac{\partial C_2}{\partial Q_2} \right) - r_2 \frac{\beta}{\alpha} = 0 \qquad (A7)$$

and

$$- \frac{\partial C_1}{\partial N} + e \frac{\partial C_2}{\partial N} - T_2 \pi + r_2 \frac{\beta}{\alpha} = 0 \qquad (A8)$$

In developing the comparative static results the signs of the elements of the vectors of equation (A1) should be stated. These come from the first order conditions and the upper and lower bounds assumed for the transfer prices.

For the vector associated with $d\tau_1$ the first order conditions indicate that,

$$\left(\frac{\partial R_1}{\partial Q_1} - \frac{\partial C_1}{\partial Q_1} - \frac{\partial g}{\partial Q_1} \right) = 0 \qquad (A9)$$

If both transfer prices equal a lower bound that is based on marginal costs than, by rearranging the definitions from table 5.1 and using

the appropriate derivative of the cost function, it can be shown
that,

$$- \frac{\partial g}{\partial Q_2} + \frac{\beta}{\alpha} = 0 \qquad \qquad \text{(A10)}$$

and

$$- \frac{\partial C_1}{\partial N} + \pi + \frac{\beta}{\alpha} = 0 \qquad \qquad \text{(A11)}$$

In this case the comparative static results for $d\tau_1$ will be zero.

If the transfer prices are greater than but not equal to
a lower bound that is based on marginal costs then (A10) and (A11)
become,

$$- \frac{\partial g}{\partial Q_2} + \frac{\beta}{\alpha} > 0 \qquad \qquad \text{(A12)}$$

and

$$- \frac{\partial C_1}{\partial N} + \pi + \frac{\beta}{\alpha} \quad \text{is indeterminant.} \qquad \text{(A13)}$$

By letting the difference between each transfer price and its lower
bound equal ε with an appropriate subscript it can be shown that
(A13) will be near zero and its sign will depend on the extent to
which each transfer price differs from its lower limit.   (A13) will
be assumed to be equal to zero in order to work out some of the
comparative static results.

If the transfer prices have a lower bound based on
average cost, where average cost is less than marginal cost, then
(A10) and (A11) become,

$$- \frac{\partial g}{\partial Q_2} + \frac{\beta}{\alpha} < 0 \qquad\qquad\qquad (A14)$$

and

$$- \frac{\partial C_1}{\partial N} + \pi + \frac{\beta}{\alpha} \quad \text{is indeterminant.} \qquad (A15)$$

These results are the same whether the lower bound is treated as an equality or an inequality. The sign of (A15) depends on the extent to which each transfer price is less than the related marginal cost term and can be either positive or negative. If (A15) equals zero, a possible but not necessary case, the comparative statics using (A14) and (A15) will be the reverse of those using (A12) and (A13).

The comparative statics using (A9), (A12), and (A13), with (A13) set equal to zero are,

$$\frac{\partial Q_1}{\partial \tau_1} > 0 \ , \qquad \frac{\partial Q_2}{\partial \tau_1} < 0 \ , \quad \text{and} \quad \frac{\partial N}{\partial \tau_1} < 0 \qquad (A16)$$

The comparative statics using (A9), (A14), and (A15), with (A15) set equal to zero, are the exact reverse of those given in (A16). The first and third result of each set can be determined from the signs of the elements of the determinant but the second requires that the determinant be multiplied out, keeping $(- \frac{\partial g}{\partial Q_2} + \frac{\beta}{\alpha})$ as a single term. The result depends on the sign of $(- \frac{\partial g}{\partial Q_2} + \frac{\beta}{\alpha})$.

To specify the determinants required for these comparative statics let,

$$h = \frac{\partial g}{\partial Q_2}$$

168

and retain the notation used to obtain (A2). Then for $\frac{\partial Q_1}{\partial \tau_1}$ the determinant is,

$$
\begin{vmatrix}
0 & -c & -b \\
-h + \frac{\beta}{\alpha} & -c - d - f & f \\
0 & f & -b - f
\end{vmatrix}
\tag{A17}
$$

For $\frac{\partial Q_2}{\partial \tau_1}$ the determinant is,

$$
\begin{vmatrix}
-a - b - c & 0 & -b \\
-c & -h + \frac{\beta}{\alpha} & f \\
-b & 0 & -b - f
\end{vmatrix}
\tag{A18}
$$

For $\frac{\partial N}{\partial \tau_1}$ the determinant is,

$$
\begin{vmatrix}
-a - b - c & -c & 0 \\
-c & -c - d - f & -h + \frac{\beta}{\alpha} \\
-b & f & 0
\end{vmatrix}
\tag{A19}
$$

The reversal of the sign of $-h + \frac{\beta}{\alpha}$ due to the assumptions used to specify the limits on the transfer price is the reason for the reversal of the comparative static results.

Two further sets of comparative static results could be worked out by assuming (A15) to be positive or negative. This has not been done for the reasons given in the main text.

In the case where both transfer prices are at the upper bound, either as an equality or an inequality,

$$
-\frac{\partial g}{\partial Q_2} + \frac{\beta}{\alpha} > 0
\tag{A20}
$$

169

since the upper bound exceeds the lower bound, and

$$- \frac{\partial C_1}{\partial N} + \pi + \frac{\beta}{-\alpha} > 0 \tag{A21}$$

by rearranging the definitions in table 5.1 and using a term ε for each trasnfer price where the bound is an inequality. The comparative statics for this case have not been worked out for the reasons given in the main text.

For the vector associated with $d\tau_2$ the term

$$e(\frac{\partial R_2}{\partial Q_2} - \frac{\partial C_2}{\partial Q_2}) - (1 + r_2) \cdot \frac{\beta}{\alpha}$$

can be signed by solving the first order condition given by equation (6) for,

$$e(\frac{\partial R_2}{\partial Q_2} - \frac{\partial C_2}{\partial Q_2})$$

and substituting this into the above expression. After rearranging this gives,

$$\frac{(1-\tau_1)}{(1-\tau_2)} \cdot \frac{\partial g}{\partial Q_2} - \frac{(1-\tau_1)}{(1-\tau_2)} \cdot \frac{\beta}{\alpha} \tag{A22}$$

so that the sign of the expression depends on $(\frac{\partial g}{\partial Q_2}) - \frac{\beta}{\alpha}$. If the transfer price equals the lower bound based on marginal costs this expression equals zero and if the transfer price is greater than this lower bound the expression is negative.

Similarly, solving equation (7) for $e(\frac{\partial C_2}{\partial N})$ and substituting this into the third element of the vector and rearranging gives,

170

$$\frac{(1-\tau_1)}{(1-\tau_2)} \{\frac{\partial C_1}{\partial N} - \pi - \frac{\beta}{\alpha}\}$$

Substituting in values for the lower bound transfer prices based on an equality to marginal costs gives,

$$\frac{(1-\tau_1)}{(1-\tau_2)} \{\frac{\partial C_1}{\partial N} - (\frac{\partial C_1}{\partial Q_1} + \frac{\partial g}{\partial Q_1}) - \frac{\partial g}{\partial Q_1}\} \qquad (A23)$$

which will equal zero. If the transfer prices are greater than the lower bound the two differences will be offsetting and the result is indeterminate. Following the reasoning given after (A16) the above expression can be treated as being zero in this inequality case.

Where transfer prices are equal to lower bounds based on marginal costs the comparative statics are equal to zero. Where the transfer prices are greater than the lower bounds the comparative statics are as follows,

$$\frac{\partial Q_1}{\partial \tau_2} < 0 \ , \qquad \frac{\partial Q_2}{\partial \tau_2} > 0 \ , \qquad \text{and} \qquad \frac{\partial N}{\partial \tau_2} > 0 \ . \qquad (A24)$$

These are the opposite of the results obtained in (A16), but the country where the tax rate is changing is also reversed.

If the transfer prices are allowed to be less than marginal costs, the comparative statics given in (A24) will be reversed, in the same way as the same change in the transfer prices reversed the results given in (A16).

For the vectors associated with dr_2 and dT_2 the signs are unambiguous and are as follows,

171

$$(1 - \tau_2) \frac{\beta}{\alpha} > 0$$

$$(1 - \tau_2) \frac{\beta}{-\alpha} < 0 \qquad\qquad (A25)$$

and

$$(1 - \tau_2)\pi > 0 \ .$$

The comparative statics are as follows,

$$\frac{\partial Q_1}{\partial r_2} < 0 \ , \qquad \frac{\partial Q_2}{\partial r_2} < 0 \ , \qquad \text{and} \qquad \frac{\partial N}{\partial r_2} > 0 \qquad\qquad (A26)$$

and

$$\frac{\partial Q_1}{\partial T_2} > 0 \ , \qquad \frac{\partial Q_2}{\partial T_2} < 0 \ , \qquad \text{and} \qquad \frac{\partial N}{\partial T_2} < 0 \ . \qquad\qquad (27)$$

Chapter Six

INTRODUCTION TO THE DYNAMIC

MODELS OF THE MULTINATIONAL

CORPORATION

Chapter Six

INTRODUCTION TO THE DYNAMIC MODELS
OF THE MULTINATIONAL CORPORATION

6.1   INTRODUCTION TO THE DYNAMIC MODELS

The purpose of this part of the thesis is to develop a dynamic model of the MNC.   Developing such a model is one of the possible extensions to the theoretical literature of the MNC.   A variety of comparative static models of increasing complexity have been developed but corresponding dynamic models, of even the simplest version of the MNC model, have not been developed to date.

The comparative static models have indicated a range of possible responses of the MNC to changes in its external environment, some of these being rather substantial.   For example, Horst (1971, p.1065) noted a case where the MNC would switch production from one country to another.   Static theories give no indication of the time required for these responses to be made but a dynamic model may say something about this.   It may also be used to consider how the process of adjustment will change if different initial conditions are assumed.

The dynamic model is developed using mathematical techniques and two different approaches are used: optimal control theory, and dynamic programing.   The model used is a dynamic

version of one of the simplest models of the MNC, the two-country, one level of production model. The assumptions and structure of the model used including any variations between the two versions, are specified in the next section of this chapter. The type of results obtained from a comparative static version of the model can be seen in Chapter Five. There are differences between the two approaches and from these follow reasons for using two approaches instead of using one approach and following it further.

An optimal control theory approach, as with the calculus approach used in Chapter Five, uses parameters specified as variables or as parts of functional forms, such as production or demand functions, and seeks to obtain necessary and sufficient conditions for a maximum while imposing no (or minimal) restrictions on the range of permissible parameter values and using functional forms that are as general as possible. In order to obtain some of the results, however, restrictive assumptions on some of the functional forms or parameter values may be required, and the former are required for the MNC model. For example, an assumption concerning the direction of trade is required.

Dynamic programing is a numerical technique that uses specific functional forms and numerical parameter values in order to calculate a maximum and is usually executed on a computer. The range of functional forms and parameter values that can be used with this technique is very wide and the effect of changing either of these can be considered by changing the functional forms or

parameter values used in the model. In this way some of the assumptions required to obtain results from an optimal control theory model can be avoided. For the MNC model developed the optimal control theory requires an assumption of a fixed capital to labour ratio in production in order to go beyond initial results while the dynamic programing technique does not require this. The limitations of the optimal control theory version are discussed further in Chapter Seven.

The optimal control theory model is set up using continuous time while the dynamic programing model is set up using discrete time periods, each of which represents a year.

6.2   STRUCTURE AND ASSUMPTIONS OF THE MODEL

In the model developed the MNC is a two-country manufacturing firm that produces and sells an identical good in each of two countries and may also export that good from one country to the other. These exports are sales from one branch of the firm to the other, and sales to the customers in each country are made by the local branch of the MNC. The basic structure of the MNC model used here builds on Horst (1971) and the basic model of the investment decision used is inspired by Nickell (1978, chapter 2). This section specifies the assumptions of the model, the reasons for, implications of, and limitations of these assumptions, and also specifies any differences in the assumptions used in the two versions of the model.

In order to develop an initial version of a dynamic model a simple version of the MNC model is used. This is chosen so that there is a correspondence with some of the work on a static model of the MNC, with a number of simplifying assumptions being taken over from the static case in order to allow for a comparison of the static and dynamic results.

There is one major difference between the two mathematical versions of the model that are developed and this effects some of the other assumptions that are used. The optimal control theory version does not include any tax variables while the dynamic programing version includes a set of tax variables. The tax variables included are specified in the next section of this chapter. The model without taxes is simpler than the model with taxes. For the optimal control theory version, which involves the manipulation of equations, this makes a difference and the simpler version was considered first. For the dynamic programing version, where the equations are calculated by computer, the difference is not as important so taxes were included. It should be noted that the exclusion of taxes is unrealistic, particularly when looking at the MNC where differences in tax rates between jurisdictions can be important. The procedure of developing a model without taxes and then adding taxes in a second stage was used by Copithorne (1971).

The model retains the assumption that the objective of the firm is the maximization of profits, as this assumption was

used in the static models discussed in Chapter Five. In dynamic form this becomes an assumption that the firm maximizes the net present value of its income stream where this income stream is the difference between its revenues and its costs at each point in time.

In order to calculate a present value an interest or discount rate is required. To simplify this and to allow a single interest rate it is assumed that there exists a perfect capital market. This ensures that economic agents are price takers in the market for funds and that any income stream can be changed for another by borrowing or lending so that only the total size and not the time path of any income stream has utility, where the size is measured by the present value.

An assumption of certainty, specifically that the world is one of perfect certainty concerning the future (or equivalently all individuals hold the same certain expectations about the future), is used. One reason for this is that it is required by the capital market assumption above so that all individuals will have the same belief about what the future interest rates will be. A second is that uncertainty is a complication that is not considered in the initial dynamic model presented here. The role of uncertainty in the investment question is considered by Nickell (1978, chapters 5 and 6). There are a number of possible different approaches to modelling uncertainty and a considerable literature in this area exists.[1] This

1. For one discussion of uncertainty see Hey (1979).

diversity of possible approaches is another reason for developing the initial model without including any type of uncertainty.

The model also assumes that the parent firm owns 100 per cent of the subsidiary. This assumption allows for the exclusion of any restrictions that would be imposed if outsiders owned a share of the subsidiary. The presence of such shareholders would limit the use of transfer prices to shift profits and force dividends to be the main method of paying profits to the owners. The use of transfer prices to shift profits would have the effect of shifting profits from other shareholders to the parent of the MNC, and thus would be opposed by the outside shareholders.

Further, it is assumed that all of the parent's investment in the subsidiary is in the form of equity. Thus, the use of intra-company debt and interest flows need not be considered.

In the model it is not specified which firm is the parent firm of the MNC and in the interpretation of the results both cases can be considered, as was done in Chapter Five. This allows for more cases to be considered than if one firm is specified as the parent at the start.

In the optimal control theory version of the model the direction of trade is specified and the MNC exports from country one to country two. As which firm is the parent firm is not specified and any of the characteristics of country one and country two can be varied the model remains completely general. The dynamic programming

version of the model allows for trade in either direction and, for each set of parameter values used calculates the optimal direction of trade.

In considering trade it is further assumed that only the MNC can engage in international trade in the good it produces so that there is no constraint on the difference in the price of the good between the two countries. If others could trade in the good, arbitrage between the two markets would impose a constraint on the price difference where this constraint would be a function of any costs of trade and any tariffs on imports. This point was considered by Horst (1971) and Copithorne (1971) and is considered in Chapter Five where the static models are discussed. A price difference constraint is another item that could be included in a later version of the model.

The basic version of the model does not include any restrictions on international transfers of funds. Thus, no restrictions are imposed in this way on the level of investment in either country or on the transfer of profits from the subsidiary to the parent.

Where taxes are included assumptions concerning the remittance of profits to the parent and the level of the transfer price are required. As the only implications of these are for tax liability they are not required for the no tax case. Assumptions concerning the repatriation of profits, and the implication of them, were discussed in Chapter Five. Similar assumptions are used here

and are discussed in the next section where taxes are discussed.
The assumption concerning limits on transfer prices was also
discussed in Chapter Five and again is important when taxes are
included, and these limits are discussed in the next section.

To produce its product the MNC is assumed to transform
inputs of capital and labour into a homogeneous output according
to some production function. The capital input is in the form
of a capital stock in each country which can be increased in
either or both countries by investment. The labour is hired in
a perfectly competitive market and the amount can be freely varied
in either country. The production function and factor prices
that the MNC faces in each country can differ between the two
countries.

Capital is assumed to have the same productive
characteristics whatever its age or birthdate. However, as it
ages it depreciates at an exponential rate. This assumption
simplifies the analysis by allowing all capital, regardless of its
age, to be treated as a single variable. Also, depreciation
depends solely on the stock of capital existing at any time and
is independent of the age structure of the capital stock.

The optimal control theory version of the model uses
a general rather than a specific production function. One condition
imposed on it is that it be a twice differentiable function. The
general functional form does not yield very concrete results and
the reasons for this are explained in Chapter Seven. The type
of functional form needed to obtain further results is also

discussed and requires an assumption of a fixed capital to labour ratio in production. Results for this are not developed as the dynamic programming version of the model allows for more freedom of choice of functional forms.

The dynamic programming version uses a Cobb-Douglas production function. This was chosen because it is one of the simplest production functions that has been widely used in the literature. It includes both capital and labour terms and allows for decreasing, constant, or increasing returns to scale in production. Other functions could be used in the type of model developed.

Assumptions concerning the methods by which the MNC may reduce its capital stock in either country are also required. The optimal control theory version includes no specific limitations on investment so includes an implicit assumption that negative investment, that is, sale of existing capital stock for its current purchase price, is allowed. Such an assumption is unrealistic and leads to the result that the firm will make large adjustments in its capital stock to make capital gains or avoid capital losses just before the price of the capital good is to rise or fall, and to reverse the change in capital stock immediately after the price change. For this to happen the assumption of certainty is also required. This is explored by Nickell (1978, pp.14-15) but will not be further considered here.

The dynamic programming version of the model does not allow for negative investment. The only way of reducing the

capital stock is to make no investment and allow depreciation
to reduce the level of the capital stock. This involves an
implicit assumption that there is no market for used capital
goods. This model does not include any costs for having unused
capital stock and allows capital stock to be left unused by
combining it with a zero level of labour. These assumptions are
not completely realistic but are used to simplify the initial
model developed.

An upper limit on the level of investment can also
be imposed. If no such limit is imposed any adjustment involving
an increase in the capital stock can take place in a single period
and there is an implicit assumption that the firm can obtain
sufficient financial resources to carry out any level of investment
it wants. Such an assumption is unrealistic as there are limits
to the amount that any firm .can borrow. Such a limit on the upper
level of investment was not included in the optimal control version
of the model as it requires that a separate constraint be included
in the mathematics, and to determine the effect of the constraint
requires that two sets of mathematical equations be worked out.

In the dynamic programming version, constraints on
investment levels can be included by minor variations in the program
used. Thus, three alternatives were used. One involved no limit
on positive investment. The second involved a constraint that the
total investment in any time period be limited to the net operating
income of the MNC in that time period, that is its income less

operating costs. The third involved some costs to having the level of investment exceed the net operating income in the same period and in the model these costs are a proportion of the extent to which the investment exceeds the net operating income.

Assumptions concerning the markets for the MNC's product and for the factors of production it uses are required. It is assumed that the MNC is a price taker on the factor markets in both countries. For its product it is assumed that the MNC faces a known downward sloping demand curve in each country. This corresponds to the assumption used for the static models and, as for those models, by excluding any reference to the MNC's competitors, involves an implicit assumption that the MNC is a monopolist. For cases of constant and increasing returns to scale in production the demand assumption is required in order to limit the size of the firm as technology imposes no finite limit on its size.

It is also assumed that the firm maintains an equality of output with demand by means of price adjustments. This assumption is used to avoid any need to include inventories or idle productive capacity in the model.

6.3   THE MODEL INCLUDING TAXES

The dynamic model of the MNC presented in the previous sections can be extended to include taxes of various types. This section describes a possible structure that can be used to include,

184

in a model, some of the main tax variables that an MNC faces.

As it has already been assumed that the MNC is one hundred per cent equity financed and that the parent firm owns one hundred per cent of the subsidiary only taxes paid by the MNC are considered and the personal income tax system and the choice of debt or equity financing for the MNC are not considered.

The full range of taxes that MNC's are subject to is complex. In this section only two types of taxes will be considered, taxes on corporate profits and tariffs on imports.[1] It is assumed that the rates of profit taxes can be different in each country and also that the tariff levels can be different. As profits are subject to tax an assumption concerning the repatriation of profits is required. The model will follow Horst (1971) in assuming that all profits are eventually repatriated to the parent firm and that all tax variables can be grouped into a single effective rate. It is also assumed that the home country allows a tax credit for the taxes paid by the subsidiary to the host country. As Batra and Hadar (1979) point out, if the model has profits taxed at the rate of the country where they are earned, the above assumption involves an implicit assumption that the home country tax rate is lower than the host country rate. Having all profits taxed at the home country

---

1. For a more detailed treatment of the tax variables facing an MNC see Horst (1977), which was discussed in Chapter Five. Additional tax variables include: withholding taxes on interest, dividend, and head office charges paid to the parent firm; and a detailed treatment of the tax credits allowed by the home country.

rate would reverse the relative tax rates involved in this implicit assumption. The use of a simplified tax structure is common to many of the models of the MNC that have been produced and it is used to simplify the models.

A number of considerations enter into the choice of the tax structure. One of these was to have a structure that could be used in either an optimal control theory or a dynamic programming model of the MNC. Another was to have a structure that did not increase the number of state variables in the model. The way in which the tax allowance for depreciation was included was particularly influenced by this.

In order to preclude the MNC from choosing an extreme value for the transfer price on trade between the two branches of the MNC it will be assumed that if the customs and tax authorities on both sides were reasonably diligent the MNC would probably not try to declare the value of its exports to be less than their marginal cost of production or greater than their market price in the exporting country. This assumption was made by Horst (1971). An alternative option of assuming a fixed transfer price was used by Eden (1978). The option adopted in the dynamic programming version is to include a fixed transfer price as a parameter and then to try a range of suitable values.

In the model profits are taxed at a rate τ , where the term "profits" is used in the accountant's sense of the difference between current revenues and current costs excluding

capital costs.[1]   Interest payments on loans can be offset

against tax at a rate $\theta\tau$.   This is because interest income

is also subject to tax at the same rate.   This tax deductability

implies that the effective rate of interest is simply $r(1-\theta\tau)$,

where r is the rate before tax.   To simplify the analysis it

will be assumed that $\theta=1$ and that the rate of tax on interest

is equal to the rate of tax on profits.   Thus, the effective rate

of interest is $r(1-\tau)$.   If $\theta<1$ in the home country then

interest payments could be a preferred method of transferring

profits from the subsidiary to the parent.   As the use of intra-

company debt has not been included in the model this is not

considered.

In addition to a tax on profits the system includes a

depreciation allowance, which allows the firm to offset against the

profits tax payable a sum which may or may not be closely related

to the actual amount by which the firm's capital has depreciated

in any given period.   The assumption that the actual rate of

depreciation is an exponential rate of decay of the capital stock

at a rate δ will be retained.   For tax purposes a proportion

$ve^{(-v(s-t))}$ of the expenditure on capital goods at time t is

allowed against tax at time s .   This is a declining balance form

of depreciation allowance.   At time s a proportion $1-e^{(-v(s-t))}$

of expenditure has already been allowed against tax and a

---

1.   The tax structure used here is taken from Nickell (1978, chapter 9, pp.199-203).

proportion $e^{(-v(s-t))}$ is still remaining to be allowed, and a fraction v of the remainder is allowed at time s. If v equals δ the depreciation allowed for tax equals the true depreciation. If $v>\delta$ the depreciation allowed for tax is greater than the rate of physical decay and this is termed accelerated depreciation.

There is also a tariff on imports into either country, represented by T. The tariff rates can be different for each country. Only the tariff of the country into which the good is being imported will enter the objective function of the MNC in the model, but both tariffs may influence the decisions of the MNC, including the extent and direction of imports.

One other fiscal instrument of governments is included in the model. This is the direct investment grant, which is a payment by the government to the firm of some percentage of the cost of all the capital equipment which it purchases. Supposing the grant to be 100g%, the effective price of capital goods to the firm is then $q(t)(1-g)$. The extent of these grants will differ in each country in the model. This allows some consideration of how government policies to encourage local investment effects the decisions of the MNC.

In order to incorporate the depreciation allowance into the model the simplest thing to do is to compute its present value at time t. This avoids the need for a second capital stock variable, if accelerated depreciation is to be allowed for. This

present value on one unit of expenditure on investment goods is given by the discounted sum of all future tax savings, namely,

$$\int_0^\infty e^{\{-r(1-\theta\tau)(s-t)\}} \, v\tau \, e^{\{-v(s-t)\}} ds$$

The first term under the integral discounts at the effective rate of interest the savings at time s back to time t. The term $ve^{\{-v(s-t)\}}$ is the depreciation allowance allowed at time s, and the τ term reduces this allowance to an amount of tax saved. Assuming that v, τ, r, and θ are expected to remain constant the present value can, by standard rules of integration, be reduced to

$$\frac{\tau v}{v+r(1-\theta\tau)}$$

The effective price of capital goods at time t, referred to as $\hat{q}(t)$, can be stated as,

$$\hat{q}(t) = q(t)(1-g)\{1 - \frac{\tau v}{v+r(1-\theta\tau)}\}$$

The tax system, as outlined above, can be included in the equation for the present value of the MNC. When depreciation allowances are included in the model in this way there is an implicit assumption that the firm always earns sufficient profits so that the depreciation allowance can be fully used to reduce the profits on which taxes are to be paid. If this is not the case the revised price of capital goods, $q(t)$, overstates the tax savings due to the depreciation allowance.

The model specified here will be developed in the next three chapters. First, the optimal control theory version will be developed in Chapter Seven. Then the dynamic programing technique

to be used will be specified in Chapter Eight and the results

obtained from it will be given in Chapter Nine.

Chapter Seven

THE   OPTIMAL   CONTROL

THEORY   MODEL

Chapter Seven

THE OPTIMAL CONTROL THEORY MODEL

This chapter develops a version of the MNC model described
in the previous chapter, by using the mathematics of optimal control
theory.   The model is set out as a system of mathematical equations
in the first section.   The results obtained from the model are
presented in section 2 with the detailed workings of the mathematics
being put in an appendix to the chapter.   The results obtained are
limited and the reasons for this are explained in section 2.

7.1   PRESENTATION OF THE MATHEMATICAL MODEL

As stated previously, the objective of the MNC is to
maximise the present value of its net income stream.   The net income
of the firm at time t in a single country, excluding international
trade, is

$$NR(t) = p(t)F(K(t),L(t)) - w(t)L(t) - q(t)I(t) \qquad (1)$$

where the notation is as given below.   The symbols are defined below
without subscripts but when subscripted refer to that item in the
country specified by the subscript, where this can be a one or a
two.

$K(t)$ = the capital stock employed by the firm at time t .

$L(t)$ = the labour input employed by the firm at time t .

$I(t)$ = the investment in new capital stock by the firm
              at time t .

$p(t)$ = the price charged by the firm for its product
              at time t .

$q(t)$ = the price of capital goods at time t .

$w(t)$ = the wage rate at time t .

$r(t)$ = the rate of interest at time t .

δ = the exponential rate of decay of capital stock.

$F\{K(t),L(t)\}$ = the maximum output which can be produced
              by the firm at time t , given $K(t),L(t)$ units
              of capital stock and labour services respectively.

The following two variables are not subscripted and must be identical

for both countries.

$N(t)$ = the quantity of output exported from the firm in
              country one to the branch in country two at time t .

$\pi(t)$ = the transfer price on $N(t)$ at time t as set by
              the MNC.   ·

The demand curve faced by the MNC is represented by the

following equation, which can be subscripted to refer to the individual

countries.

$$z\{p(t)\}\beta(t) \tag{2}$$

where $z_p < 0$.   This demand function is of a separable form where

the demand curve itself has a constant shape defined by $z\{p(t)\}$

and is shifted up or down over time by $\beta(t)$.   One result of this

form is that the elasticity of demand, ε , and the marginal revenue,

MR, are both functions of $p(t)$ only, time not entering as a

separate argument.[1] The $\beta(t)$ term will be useful in allowing

consideration of how growth of demand in a market over time effects

the investment decision of the MNC.

The assumption that price is used to keep demand equal

to production gives the following equation,

$$z\{p(t)\}\beta(t) = F\{K(t),L(t)\} \tag{3}$$

and this can be rearranged to give,

$$p(t) = p\{F\{K(t),L(t)\}/\beta(t)\} \tag{4}$$

Substituting (4) for the price term in the net income equation and

including international trade, the objective function of the MNC

can be stated as follows:

$$\int_0^\infty e^{(-R(t))} \{p_1\{\{F_1\{K_1(t),L_1(t)\} - N(t)\}/\beta_1(t)\}\{F_1\{K_1(t),$$

$$L_1(t)\} - N(t)\} - w_1(t)L_1(t) - q_1(t)I_1(t) + \pi(t)N(t) \tag{5}$$

$$+ p_2\{\{F_2\{K_2(t),L_2(t)\} + N(t)\}/\beta_2(t)\}\{F_2\{K_2(t),L_2(t)\}$$

$$+ N(t)\} - w_2(t)L_2(t) - q_2(t)I_2(t) - \pi(t)N(t)\}dt$$

This is maximised subject to the following conditions,[2]

$$\dot{K}_1(t) = I_1(t) - \delta_1 K_1(t) \tag{6}$$

$$\dot{K}_2(t) = I_2(t) - \delta_2 K_2(t) \tag{7}$$

---

1. This is shown by Nickell (1978, pp.17,21).
2. A dot over a variable always represents the time derivative, i.e.

$$\dot{K}(t) = \frac{dK(t)}{dt}$$

194

$$K_1(0) = K_{10} \qquad (8)$$

$$K_2(0) = K_{20} \qquad (9)$$

In this model exports from country one, $N(t)$, should be constrained to be less than production in country one, $F_1\{K_1(t),L_1(t)\}$. Since investment in country one and the level of exports are simultaneously determined and are influenced by the same variables the level of investment should always be such that the export requirement can be met. This point will be considered when the results of the model are examined.

This model can be set up as an optimal control problem where labour employed, investment, and the quantity of exports from country one are the control variables and the capital stocks are the state variables. The mathematics of this model are worked out in the appendix with the basic model being presented in section 7.3.1 of the appendix.

In this model the transfer price is not listed as a control variable although it is set by the MNC. The reason for this is that while the control variables involve real quantities the transfer price is a financial variable only and is used to transfer funds between the two branches of the MNC. When taxes are included in the model the transfer price will determine certain tax liabilities and certain conditions will result which determine the transfer price or which will limit the transfer price to a certain range. This is consistent with Horst (1971) where a

separate assumption that transfer prices are set so as to minimize taxes payable was required in order to determine the transfer prices.

7.2   RESULTS OF THE MODEL

The first results to be presented are a set of equations giving conditions involving the marginal revenues in the two countries.   These are derived in section 7.3.3 of the appendix as equations (A17), (A18), (A21), (A22), and (A19), and are given below.

$$MR\{p_1(t)\}F_{L1}(t) \ = \ w_1(t) \tag{10}$$

$$MR\{p_2(t)\}F_{L2}(t) \ = \ w_2(t) \tag{11}$$

$$MR\{p_1(t)\}F_{K1}(t) \ = \ q_1(t)\{r(t) + \delta_1 - \dot{q}_1(t)/q_1(t)\} \tag{12}$$

$$MR\{p_2(t)\}F_{K2}(t) \ = \ q_2(t)\{r(t) + \delta_2 - \dot{q}_2(t)/q_2(t)\} \tag{13}$$

$$MR\{p_1(t)\} \ = \ MR\{p_2(t)\} \tag{14}$$

Conditions (10) through (13) state that in each country each factor of production is employed up to the point where its marginal revenue product just covers its cost.   These are fairly standard results for a maximizing model to yield.

These results are similar to some of those obtained in some of the comparative static models of the MNC.   Horst (1971) provides a useful model to compare with as the basic structure of the models are similar.   Horst, however, had a single term for

costs and did not include a production function. His results,

summarized in chapter five, were that marginal revenue equals

marginal cost in each country and that the marginal costs for the

two countries will be equal except for a tax term, and this term

will vanish if all tax rates are assumed to be zero. The marginal

revenue/marginal cost conditions correspond to equations (10) to

(13) where the marginal revenue products of the factors of production

appear in place of the marginal cost terms. The connection between

the two countries is expressed in terms of marginal revenues in the

dynamic model and given the other conditions in the models this is

equivalent to the results in terms of marginal costs obtained by Horst.

The cost of capital term, $q(t)\{r(t) + \delta - \dot{q}(t)/q(t)\}$,

gives the cost of employing the services of one unit of capital stock

for one time period, or in other words, a flow price of capital.

The term $q(t)r(t)$ is the interest charged on $q(t)$ for one period,

$q(t)\delta$ is the depreciation charge incurred, and $q(t) \cdot \dot{q}(t)/q(t) = \dot{q}(t)$ is

the rise in the price of a unit of capital stock during the course of

the time period. This term appears with a negative sign since a

rise in the price of capital stock represents a gain for its owner

and thus offsets the other elements of capital cost.

The version of the model presented here does not include

a constraint that gross investment be positive. This allows negative

investment to take place if it is required in order for condition (14)

to be met.

Condition (14), which is due to the inclusion of the term

representing exports from country one to country two, states that
this trade will be used to make the marginal revenue of sales equal
in the two countries. This equality is due to the lack of any
taxes and tariffs in the model. This allows the right hand side
of equation (A19) to equal zero as $\pi(t) - \pi(t)$ equals zero, which
it would not do if the positive and negative transfer price terms
had each been multiplied by different tax or tariff terms. This
result conforms to those obtained in the static models of the MNC
that were discussed in chapter five. It can also be noted that
due to the omission of all tax terms no condition results that in
any way limits the choice of transfer price made by the MNC.

One of the results used in the derivation of the marginal
conditions shows the net addition to the present value of the firm
at time zero due to the purchase of an additional unit of capital
stock at time t , assuming· N remains constant. As exports N
will not always remain constant when investment is undertaken this
pair of conditions must be interpreted and used with care. They
are derived as (A15) and (A16) and are given below.

$$\int_0^\infty e^{(-R(s))} e^{(-\delta_1 (s-t))} \{ \frac{F_{K_1}(s)}{z_{p1} \beta_1 (s)} \{ Q_1 (s) - N(s) \} \tag{15}$$

$$+ P_1 (s) F_{K_1}(s) \} \, ds - q_1 (t) e^{(-R(t))} = 0$$

$$\int_0^\infty e^{(-R(s))} e^{(-\delta_2(s-t))} \left\{ \frac{F_{K_2}(s)}{z_{p2}\beta_2(s)} \{Q_2(s) + \dot{N}(s)\} \right. \tag{16}$$

$$\left. + P_2(s) F_{K_2}(s) \right\} ds - q_2(t) e^{(-R(t))} = 0$$

These equations will be equal to zero on the optimum path. If the value was positive (or negative) the investment in one additional (less) unit of capital will increase the net income flow of the MNC.

It is also desirable to derive from the model investment conditions giving the level of investment in each country as a function of the demand and production parameters in both countries and to derive a trade condition giving the level of trade as a function of the demand and production parameters in both countries. This was attempted but no satisfactory results were obtained. Part of the reason for this is the presence of the trade term, $\dot{N}$, in the demand equation of each country. The equation that should yield a value for $\dot{N}$, equation (A6), yields the marginal revenue condition given in equation (A19), but this condition does not include N explicitly so can not be solved for N. If the model included tax terms, equation (A19) would include the transfer price term but would still not include N explicitly.

For each country the demand equation plus the marginal revenue product conditions, equations (3), (10) and (12) for country one, can give a condition for the level of investment in terms of the production and demand parameters of that country and the level of trade. Since both the level of investment and the

level of trade will change together such a condition is not very informative.

The option of using specific functional forms in the equations was considered. In order that any further results be attainable an assumption of a constant capital to labour ratio was required so that the labour term could be eliminated from the model. As the dynamic programing model allows for more freedom of choice of functional forms, including the use of a larger number of state and control variables, this approach was not pursued here.

The model developed here can be extended to include taxes. The objective function for the MNC, using the tax structure described in section 6.3, and the simplifying notation given in the appendix, is

$$\int_0^\infty e^{(-r(t))} \{(1-\tau_1)\{P_1(t)(Q_1(t) - N(t))\} \tag{17}$$

$$- (1-\tau_1)w_1(t)L_1(t) - \hat{q}_1(t)I_1(t) + \pi(t)N(t)(1-\tau_1)$$

$$+ (1-\tau_2)\{P_2(t)(Q_2(t) + N(t))\} \ .$$

$$- (1-\tau_2)w_2(t)L_2(t) - \hat{q}_2(t)I_2(t) - (1+T_2)\pi(t)N(t)(1-\tau_2)\} \ dt$$

In structure the above objective function is identical to equation (5), the objective function without tax terms. The constraints imposed on this function are the same as those given in equations (6) to (9) inclusive. Thus, the same mathematical methods as used to obtain

preliminary results in the no tax case can be used to obtain

corresponding results here.   The same problems would arise in

trying to develop further results.

7.3 MATHEMATICAL APPENDIX

7.3.1 Basic equations of the model

To solve the model of the MNC as an optimal control problem the following Hamiltonian is set up:

$$H = e^{(-R(t))}\{P_1\{\{F_1\{K_1(t),L_1(t)\} - N(t)\}/\beta_1(t)\}. \qquad (A1)$$

$$\{F_1\{K_1(t),L_1(t)\} - N(t)\} - w_1(t)L_1(t) - q_1(t)I_1(t)$$

$$+ \pi(t)N(t) + P_2\{\{F_2\{K_2(t),L_2(t)\} + N(t)\}/\beta_2(t)\}.$$

$$\{F_2\{K_2(t),L_2(t)\} + N(t)\} - w_2(t)L_2(t) - q_2(t)I_2(t)$$

$$+ \pi(t)N(t)\} + \lambda_{K1}(t)\{I_1(t) - \delta_1 K_1(t)\}$$

$$+ \lambda_{K2}(t)\{I_2(t) - \delta_2 K_2(t)\}$$

Before proceeding to the necessary conditions the partial derivatives of the demand equations should be given. These can be obtained by referring back to equation (3), including the export term in the equation, and taking derivatives to obtain the following,

$$\frac{\partial P}{\partial K} = \frac{F_K(t)}{z_p \beta(t)}$$

$$\frac{\partial P}{\partial L} = \frac{F_L(t)}{z_p \beta(t)}$$

and

$$\frac{\partial P}{\partial N} = \frac{1}{z_p \beta(t)}$$

where

$$F_K(t) = \frac{\partial F\{K(t),L(t)\}}{\partial K}$$

and

$$F_L(t) = \frac{\partial F\{K(t),L(t)\}}{\partial L}$$

To simplify the notation for the rest of the appendix let

$$Q(t) = F\{K(t),L(t)\}$$

and

$$P(t) = P\{\{F\{K(t),L(t)\} \pm N(t)\}/\beta(t)\}$$

with the appropriate country subscripts and sign for N(t).

The necessary conditions give the following:

$$\frac{\partial H}{\partial I_1} = e^{(-R(t))}\{- q_1(t)\} + \lambda_{K_1}(t) = 0 \qquad (A2)$$

$$\frac{\partial H}{\partial I_2} = e^{(-R(t))}\{- q_2(t)\} + \lambda_{K_2}(t) = 0 \qquad (A3)$$

$$\frac{\partial H}{\partial L_1} = e^{(-R(t))}\{\frac{F_{L_1}(t)}{z_{p1}\beta_1(t)}\{Q_1(t) - N(t)\} + P_1(t)F_{L_1}(t)$$

$$- w_1(t)\} = 0 \qquad (A4)$$

$$\frac{\partial H}{\partial L_2} = e^{(-R(t))}\{\frac{F_{L_2}(t)}{z_{p2}\beta_2(t)}\{Q_2(t) + N(t)\} + P_2(t)F_{L_2}(t)$$

$$- w_2(t)\} = 0 \qquad (A5)$$

$$\frac{\partial H}{\partial N} = e^{(-R(t))} \frac{1}{z_{p1}\beta_1(t)}\{Q_1(t) - N(t)\} + P_1(t)(-1)$$

$$+ \pi(t) + \frac{1}{z_{p2}\beta_2(t)}\{Q_2(t) + N(t)\} + P_2(t)(1)$$

$$+ \pi(t)\} = 0 \qquad (A6)$$

Two additional derivatives of the Hamiltonian give,

$$\frac{\partial H}{\partial K_1} = e^{(-R(t))} \{ \frac{F_{K_1}(t)}{z_{p1}\beta_1(t)} \{Q_1(t) - N(t)\} + P_1(t)F_{K_1}(t)\}$$

$$+ \lambda_{K_1}(t)(-\delta_1) \qquad\qquad (A7)$$

$$\frac{\partial H}{\partial K_2} = e^{(-R(t))} \{ \frac{F_{K_2}(t)}{z_{p2}\beta_2(t)} \{Q_2(t) + N(t)\} + P_2(t)F_{K_2}(t)\}$$

$$+ \lambda_{K_2}(t)(-\delta_2) \qquad\qquad (A8)$$

The adjoint conditions require that

$$\frac{\partial \lambda K_1(t)}{\partial t} = - \frac{\partial H}{\partial K_1}$$

and

$$\frac{\partial \lambda K_2(t)}{\partial t} = - \frac{\partial H}{\partial K_2}$$

The transversality conditions require that

$$\lim_{t \to \infty} \lambda_{K_1}(t) K_1(t) = 0$$

and

$$\lim_{t \to \infty} \lambda_{K_2}(t) K_2(t) = 0$$

7.3.2   Derivation of values for the λ's

The adjoint conditions and equations (A7) and (A8) give,

$$\dot{\lambda}_{K_1}(t) = \lambda_{K_1}\delta_1 - e^{(-R(t))}\{\frac{F_{K_1}(t)}{z_{p1}\beta_1(t)}\{Q_1(t) - N(t)\}$$

$$+ P_1(t)F_{K_1}(t)\} \tag{A9}$$

and

$$\dot{\lambda}K_2(t) = \lambda_{K_2}\delta_2 - e^{(-R(t))}\{\frac{F_{K_2}(t)}{z_{p2}\beta_2(t)}\{Q_2(t) + N(t)\}$$

$$+ P_2(t)F_{K_2}(t)\} \tag{A10}$$

These can be solved for values of $\lambda_K(t)$. Using a standard formula gives,[1]

$$\lambda_{K_1}(t) = e^{-\int-\delta_1 dt}\{A + \int-e^{(-R(t))}\{\frac{F_{K_1}(t)}{z_{p1}\beta_1(t)}\{Q_1(t) - N(t)\}$$

$$+ P_1(t)F_{K_1}(t)\}e^{\int-\delta_1 dt}dt$$

Since $\int-\delta_1 dt = -\delta_1 t$ this can, omitting the contents of some of brackets, be restated as,

$$\lambda_{K_1}(t) = e^{\delta_1 t}\{A + \int-e^{(-R(t))}\{ \qquad \}e^{-\delta_1 t}dt\} \tag{A11}$$

Multiplying by $e^{-\delta_1(t)}$ and, from the transversality condition, using the condition that $\lambda_{K_1}(t)\to 0$ as $t\to\infty$ gives,

$$A = -\int e^{-\delta_1 t}\{-e^{(-R(t))}\}\{ \qquad \}dt$$

---

1. One source for this is Chiang (1974, pp.477-479).

where the integral goes from 0 to t and is evaluated for the upper limit at $t = \infty$. Representing this by $\int(\infty)$ and substituting the value for A into equation (A11) gives,

$$\lambda_{K_1}(t) = e^{\delta_1 t}\{-\int(\infty) + \int -e^{(-R(t))}\{ \qquad \}e^{-\delta t}dt\} \qquad (A12)$$

Evaluating (A12) for the upper limit at t gives,

$$\lambda_{K_1}(t) = e^{\delta_1 t}\{-\int(\infty) + \int(t)\}$$

where $\int(t)$ represents the integral evaluated for the upper limit at t. Combining the integrals into a single integral with the appropriate limits of integration gives

$$\lambda_{K_1}(t) = e^{\delta_1 t}\{-\int_t^\infty \qquad dt\}$$

which is

$$\lambda_{K_1}(t) = e^{\delta_1 t}(-1)\int_t^\infty -e^{(-R(t))} \; e^{(-\delta_1(s))}\{\frac{F_{K_1}(s)}{z_{p_1}\beta_1(s)}\{\dot{Q}_1(s)$$

$$- N(s)\} + \dot{P}_1(s)F_{K_1}(s)\}ds$$

Cancelling the minus terms that are inside and outside the integral sign, and moving the $e^{\delta t}$ term inside the integral sign gives,

$$\lambda_{K_1}(t) = \int_t^\infty e^{(-R(s))} \; e^{(-\delta_1(s-t))}$$

$$\{\frac{F_{K_1}(s)}{z_{p_1}\beta_1(s)}\{\dot{Q}_1(s) - N(s)\} + \dot{P}_1(s)F_{K_1}(s)\} \; ds \qquad (A13)$$

206

By similar reasoning as used to get from (A9) to (A13), from (A10) we obtain,

$$\lambda_{K_2}(t) = \int_t^\infty e(-R(s))\, e^{(-\delta_2(s-t))}$$

$$\{\frac{F_{K_2}(s)}{z_{p_2}\beta_2(s)}\{Q_2(s) + N(s)\} + P_2(s)F_{K_2}(s)\}\, ds \qquad (A14)$$

Substituting (A13) and (A14) into (A2) and (A3) and rearranging so that all the terms are on one side gives,

$$\int_t^\infty e^{(-R(s))}\, e^{(-\delta_1(s-t))}\{ \qquad \}\, ds - q_1(t)e^{(-R(t))} = 0 \qquad (A15)$$

and

$$\int_t^\infty e^{(-R(s))}\, e^{(-\delta_2(s-t))}\{ \qquad \}\, ds - q_2(t)e^{(-R(t))} = 0 \qquad (A16)$$

7.3.3 Derivation of the marginal revenue conditions

Recall that $\dfrac{F_{L_1}(t)}{z_{p_1}\beta_1(t)} = \dfrac{\partial P_1}{\partial L_1}$ and that

$F_L = \dfrac{\partial F\{K(t),L(t)\}}{\partial L(t)}$ and that $MR = P + Q\dfrac{\partial P}{\partial Q}$ where MR is marginal

revenue. Starting with equation (A4) and rearranging it gives,

$$\frac{\partial P_1}{\partial L_1}Q_1(t) - P_1(t)F_{L_1}(t) = w_1(t)$$

rearranging

$$P_1(t)F_{L_1}(t) + \frac{\partial P_1}{\partial Q_1}\frac{\partial Q_1}{\partial L_1}Q_1(t) = w_1(t)$$

and

$$\{P_1(t) + \frac{\partial P_1}{\partial Q_1}Q_1(t)\}\, F_{L_1}(t) = w_1(t)$$

207

finally,

$$MR\{P_1(t)\}F_{L1}(t) \;=\; w_1(t) \tag{A17}$$

Similar reasoning from (A5) gives,

$$MR\{P_2(t)\}F_{L2}(t) \;=\; w_2(t) \tag{A18}$$

Starting with equation (A6) and using the above notation gives,

$$e^{(-R(t))}\{\frac{1}{z_{p1}\beta_1(t)} Q_1(t) - P_1(t) + \pi(t)\}$$

$$+ \; e^{(-R(t))}\{\frac{1}{z_{p2}\beta_2(t)} Q_2(t) + P_2(t) - \pi(t)\} \;=\; 0$$

which rearranges to

$$\frac{\partial P_1}{\partial N}Q_1 - P_1 + \frac{\partial P_2}{\partial N}Q_2 + \dot{P}_2 \;=\; (\pi(t) - \pi(t))$$

and to

$$\frac{\partial P_1}{\partial Q_1}\frac{\partial Q_1}{\partial N}Q_1 - P_1 + \frac{\partial P_2}{\partial Q_2}\frac{\partial Q_2}{\partial N}Q_2 + P_2 \;=\; 0$$

Recalling that $Q_1(t) = F_1\{K_1(t),L_1(t)\} - N(t)$ and that
$Q_2(t) = F_2\{K_2(t),L_2(t)\} + N(t)$ and taking the appropriate derivatives gives,

$$\frac{\partial Q_1}{\partial N} \;=\; -1 \qquad \text{and} \qquad \frac{\partial Q_2}{\partial N} \;=\; 1$$

Therefore,

$$- \frac{\partial P_1}{\partial Q_1} Q_1 - P_1 + \frac{\partial P_2}{\partial Q_2} Q_2 + P_2 = 0$$

and finally,

$$- MR\{P_1(t)\} + MR\{P_2(t)\} = 0 \qquad \text{(A19)}$$

From equations (A15) and (A16) two additional conditions can be obtained. Starting with (A15) and taking its time derivation gives,

$$\delta_1 \int_t^\infty e^{(-R(t))} e^{(-\delta_1(s-t))} \{ \qquad \} ds$$

$$+ e^{(-R(t))} \{ \frac{F_{K1}(t)}{z_{p1} \beta_1(t)} \{Q_1(t) - N(t)\} + P_1(t) F_{K1}(t) \}$$

$$+ r(t) q_1(t) e^{(-R(t))} - \dot{q}_1(t) e^{(-R(t))} = 0$$

Substituting in for the integral from a rearranged (A15) gives,

$$\delta_1 e^{(-R(t))} q_1(t) - e^{(-R(t))} \{ \qquad \}$$

$$+ r(t) q_1(t) e^{(-R(t))} - \dot{q}_1(t) e^{(-R(t))} = 0$$

Cancelling the $e^{(-R(t))}$ terms and rearranging gives,

$$\frac{F_{K1}(t)}{z_{p1} \beta_1(t)} \{Q_1(t) - N(t)\} + P_1(t) F_{K1}(t)$$

$$= q_1(t) \{r(t) + \delta_1 - \dot{q}_1(t)/q_1(t)\} \qquad \text{(A20)}$$

By the same reasoning as used to get from (A4) to (A17), (A20) can be reduced to,

$$MR\{P_1(t)\} \; F_{K_1}(t) \;\; = \;\; q_1(t)\{r(t) \; + \; \delta_1 \; - \; \dot{q}_1(t)/q_1(t)\} \qquad (A21)$$

By identical reasoning equation (A16) will yield,

$$MR\{P_2(t)\} \; F_{K_2}(t) \;\; = \;\; q_2(t)\{r(t) \; + \; \delta_2 \; - \; \dot{q}_2(t)/q_2(t)\} \qquad (A22)$$

Chapter Eight

THE ANALYTICS OF THE

DYNAMIC PROGRAMMING

MODEL

.

Chapter Eight

THE ANALYTICS OF THE DYNAMIC
PROGRAMMING MODEL

Dynamic programming is a mathematical technique for
finding the optimum of a system, where the system is described
by a set of mathematical relationships.   There are a number of
types of problems that it can be used to consider.   Here it is
used to find a maximum for a discrete multistage decision process
problem, where each decision is associated with a value by some
rule.   The system is the set of equations and conditions used to
describe the MNC.   The decision process involves selecting levels
of investment, labour usage, and trade between the two countries.
The value is the present value of the profit stream of the MNC.
It is a discrete problem as the decisions are made once for each
time period (conveniently regarded as years).

Dynamic programming solves the optimization problem
numerically.   In this it differs from optimal control theory where
the problem is solved analytically.   There are a number of ways
in which a dynamic programming problem can be set up.   The specific
program used is described in the first section of the chapter and
the equations of the model of the MNC are specified in the second
section.

There are two types of problems that can be considered. In the first, the original problem has numberical values associated with it, such as trying to solve a specific engineering problem involved in the production of some good. In the second, the original problem is a general class of problem without specific numerical values where illustrative results covering a range of possible values are desired. The latter case is the one considered here. The range and choice of values used and the reasons for this choice are given in section 3 of the chapter.

The final section of the chapter gives a listing of the specific computer program used and also gives a sample of the output it produced.

8.1   STRUCTURE OF THE DYNAMIC MODEL

The dynamic program is used to find an optimum time path for a MNC to follow, where this time path is specified in terms of the levels of capital stocks, investment, labour usage, and trade chosen by the MNC. The MNC is described in Chapter Six and is specified by the equations given in the next section of this chapter. The optimal time path is defined as that which maximizes the present value of the MNC's profit stream over time. As explained in Chapter Six, the capital stocks are state variables and the other variables listed above are control variables.

The specific dynamic program used here involves a grid search technique, where this search is over the relevant values

of the variables that can be chosen by the MNC and across all of the time periods included in the model. Given the way the program was set up it was possible to calculate the level of trade rather than find its value by a search technique. This is explained in the next section.

The grid search works by calculating, for each combination of capital stocks in countries 1 and 2, the levels of the control variables that result in the maximum present value. To find the maximum present value a calculation for each possible combination of the control variables is done. The present value of the first calculation is stored, along with the values of the control variables. The present value of each subsequent calculation is compared to the stored value and if it is higher the full set of stored values is replaced. When all the calculations are completed the values stored are the maximum present value and the associated values of the control variables. As explained later in this section, this calculation was broken into two parts in order to reduce the total number of calculations required. Also, the calculation works backward through the time periods.

The variables for which a search technique was applied all have a lower bound of zero. Thus, the range of values used started at zero. These variables have no fixed upper value. The demand function parameters of the model, by limiting the possible sales of the MNC's product, restrict the range that must be considered. The largest value used in the search much exceed the

largest corresponding value appearing in the results. A check
of the output is sufficient to show if this is the case. When
it is not, the program is re-run using the same parameter set
but a larger range for the search.

While the variables can change by unit increments it
is not necessary to use all possible values in the search. A
limited number of points along the range of values can be used with
interpolation being used to allow for the in between values. The
number of points used in the search must be sufficient so that the
results from any particular set of parameters will be stable if
the choice of points used is altered, provided both sets of points
meet the other requirements specified here. To allow for a
standardized and reasonably simple interpolation procedure to be
used over the full range searched, it was necessary for the points
searched for each variable to be at evenly spaced intervals. For
the results to be stable it was found that the value of the first
non-zero point used could not be too much larger than the lowest
value used in the results. When this value was zero the use of a
smaller grid size could be tried and a check of results using
similar parameters and of the results of the static models discussed
in Chapter Five helped decide how small the points searched should
be.

Re-running the program with different numbers of
points included in the search indicated that using 10 points for
each capital stock and investment variable and 20 points for each

labour usage variable gave satisfactory results. For some cases however, 15 points were used for each investment variable. Increasing the number of points used increases the computer time required to run the program.

In the actual computer program the number of increments was specified by a variable defined in the program and the size of the increments were read in as data by the program. Thus it was easy to change the size of the increments used and to change the number of points used, as it was only necessary to change the specification of a variable and the size of one or two arrays. From the information provided the program calculated the points to be searched.

It is possible to carry out the search procedure across all time periods while only requiring data from two time periods at any point in the calculation. To do this the program works backwards through the time periods and for the later of the two time periods considered at any point requires a value representing the present value for the operations of the MNC in later periods. This is required for each combination of capital stocks in countries 1 and 2 that is used as a search point. To start the process a set of present value figures for the final time period is used. These can be arbitrary and can be entered as data, but in the program used are calculated at an intermediate step. These values will effect the time path for the final few periods, but the number of periods used is sufficient to allow for this.

The values calculated in this process are stored in an array, where this array stores values for each combination of the two state variables, the capital stocks. The values stored are the levels of the control variables, investment, labour usage, and trade. The present value resulting from the calculation is also stored in the array.

Once the calculation has been completed for all periods the optimal path for the MNC is traced out starting from the initial capital stocks put in as parameters. The level of gross investment, combined with depreciation give the capital stock in the next period. By interpolating from the stored values in the array the levels of labour usage and trade associated with these capital stocks and the levels of investment can be determined, tracing a path through until the final period is reached. When this path is printed out the prices and quantities, which were calculated but not stored are re-calculated and also listed.

A number of features have been used in the program in order to reduce the total amount of calculation involved. The calculation of the optimum can, for this problem, be divided into two stages. For each time period, for each combination of the two capital stocks, the levels of labour usage and trade can be determined independently of the levels of investment. The first set of variables is sufficient to determine the quantities produced, quantities sold, prices, and labour costs for each time period.

The levels of investment determine the capital stocks available
for the next period.

For each possible capital stock combination that a
firm can have in a period the best it can do is to maximize its
net operating income, income less operating costs, in that period.
This involves decisions concerning only the first set of the above
mentioned variables. This decision will remain the same as long
as the parameters of the problem remain the same. Thus, this
first calculation does not need to be done for each time period but
only for each set of parameters used in the model.

The program allows for two sets of parameter values.
The parameter values to be used are read into two valued arrays
and the results array has a similar two valued direction. The
calculation specified above is done twice with an index variable
controlling the parameter set used and the part of the results array
used. In the calculation across time periods a similar index
variable is used to control the parameter set and set of initial
results used. The period at which the parameter set should be
changed is specified in the input. When the calculation is done
for each time period a test is done to determine whether the first
or second parameter set is to be used and the index variable set
accordingly. A similar procedure is used when the optimal time
path is set out.

The choice of the levels of investment, and the
determination of the optimum levels of capital stock, involves a

comparison across the present value of the profits associated

with each future attainable capital stock position. The search

procedure, by working backward through time, requires data from

only two time periods at any point in the calculation. This

calculation required present value figures for the latter time

period. Thus, to start the calculation process present value

figures for each combination of capital stocks in the final time

period must be entered as data. The values used, instead of

being assumed, were obtained from the calculation of the net

operating income described above, using the results for the para-

meters set applicable to the final time period. To obtain a

present value for each capital stock combination the corresponding

net operating income was reduced by the investment expenditure

required to maintain the levels of capital stock by replacing

depreciation. This calculation provides reasonable values for any

parameter set used with the program, thus avoiding the need to

change a set of assumed values when the parameter set is changed.

In the main calculation a present value must be

found for each capital stock combination in the earlier period.

To do this each combination of levels of investment is used to find

a capital stock position in the next period and to calculate a profit

for the present period by reducing the net operating income by the

level of investment expenditure. The present value of the latter

period is discounted for one period and added to the profit figure

to obtain a present value for the earlier period. A comparison

across these, using the procedure described above, is used to
find the maximum present value for each capital stock combination.
This procedure is used, as described above, to work backwards
through the time periods, after which the optimal path is determined
and printed out.

8.2   MODEL   USED

        This section specifies the mathematical form of
the model used, including the equations used and the methods used
to include the constraints on the level of investment.   The order
in which the equations are specified is different from that used
in Chapter Seven.   When the equations are stated subscripts of
"1" and "2" are used to designate the two countries, and a
subscript of i is used when an equation has an identical form
for both countries.

        The first equation considered is the production
function.   This is of the Cobb-Douglas form,

$$Q_i = A_i K_i^{\alpha_i} L_i^{\beta_i}$$

where the form is identical in both countries but the values of
the parameters can differ.   The variables are defined as follows:

Q_i = quantity produced in country i, represented in the
program by Q_i.

A_i = the scale factor, represented in the program by
SCALEi.

K_i = the capital stock of the MNC in country i,
represented in the program by K_i.

β_i = the exponent on the capital stock, represented in the program by EXPKi.

L_i = the quantity of labour used by the MNC in country i, represented in the program by L_i.

α_i = the exponent on the quantity of labour, represented in the program by EXPLi.

Since production takes place in each time period all the variables and parameters in the above equation can also have a time subscript although the values assigned to them may be constant or change only once over all time periods. This holds true for many of the other equations as well. The previous section of the chapter described how the dynamic program was arranged to allow for multiple time periods while at the same time minimizing multiple calculations of any equation.

The demand functions are specified as follows:

$$P_1 = a_1 - b_1 (Q_1 - N)$$

$$P_2 = a_2 - b_2 (Q_2 + N)$$

where

P_i = the price charged by the MNC for its product in country i, represented in the program by P_i.

a_i = the price intercept of the linear demand curve in country i and is the price when the quantity sold equals zero. It is represented in the program by SIZEi.

b_i = the slope of the demand curve in country i and gives the numerical price change for a unit increase in quantity. b_i is positive since there is a minus sign in front of it. It is represented in the program by DECLi.

N   =   the quantity of the MNC's product traded between the two countries represented in the program by N. When N is positive trade is from 1 to 2 and when N is negative trade is from 2 to 2.

The terms $(Q_1 - N)$ and $(Q_2 + N)$ are included because the quantity produced, adjusted by the amount traded, gives the quantity sold in each country. As the sign of N changes when the direction of trade changes these two terms are independent of the direction of trade.

It is useful to distinguish between the firm's operations in one period and its operations over all time periods. In each time period the firm can use the capital stock it has at the start of that period with any quantity of labour to produce an output which it will sell in that period. Any investment will change the capital stock available in the next period.

The equation for the capital stock is

$$K_i(t+1) = K_i(t)(1-\delta_i(t))+I_i(t)$$

where

$I_i(t)$ =   investment in country i in period t , represented in the program by I_i.

δ_i =   rate of depreciation in country i , in period t , represented in the program by DEPi.

An equation for the MNC's net operating income, i.e. its total income less non capital costs, in each time period can be given. It is

$$NR = (1-\tau_1)(P_1 \cdot (Q_1 - N) - W_1 L_1 + \pi N)$$

$$+ (1-\tau_2)(P_2 \cdot (Q_2 + N) - W_2 L_2 - (1+T_2)\pi N)$$

where   N > 0   and trade is from country 1 to country 2 and is

$$NR = (1-\tau_1)(P_1 \cdot (Q_1-N) - w_1 L_1 + (1+T_1)\pi N)$$

$$+ (1-\tau_2)(P_2 \cdot (Q_2+N) - w_2 L_2 - \pi N)$$

where   N < 0   and trade is from country 2 to country 1.   The

difference between the two equations is the inclusion of either T_2

or T_1, the tariff on imports, and depends on the direction of trade.

Because the sign of   N   changes when the direction of trade changes

no other changes are required.   The additional variables are

defined as follows:

τ_i =   the rate of tax on profits in country i as defined
in section 6.3, represented in the program as TAXi.

w_i =   the annual wage rate in country i, represented in
the program as WAGEi.

π =   the transfer price set by the MNC on the good it
trades, represented in the program as TPRICE.

T_i =   the tariff rate on imports in country i, represented
in the program as TARIFFi.

This equation is used in the dynamic program to

determine the levels of labour and trade, and thus prices and

quantities sold also, that will be used with each combination of

capital stock considered.   A grid search method is used to find

the two levels of labour utilized but the level of trade can be

calculated using partial derivaties of the equation for the net

operating income.   The partial derivatives are obtained by

substituting the demand and production equations into the NR

equations.

223

for N > 0

$$\frac{\partial NR}{\partial N} = (1-\tau_1)(-a_1 + 2b_1 Q_1 - 2b_1 N + \pi)$$

$$+ (1-\tau_2)(a_2 - 2b_2 Q_2 - 2b_2 N - (1+T_2)\pi)$$

and for N < 0

$$\frac{\partial NR}{\partial N} = (1-\tau_1)(-a_1 + 2b_1 Q_1 - 2b_1 N + (1+T_1)\pi)$$

$$+ (1-\tau_2)(a_2 - 2b_2 Q_2 - 2b_2 N - \pi)$$

At a maximum these will be equal to zero and can be re-arranged
to give the following equations for N.   For N > 0

$$N = \{(1-\tau_1)(-a_1 + 2b_1 Q_1 + \pi)$$

$$+ (1-\tau_2)(a_2 - 2b_2 Q_2 - (1+T_2)\pi)\}$$

$$/\{(1-\tau_1)2b_1 + (1-\tau_2)2b_2\}$$

and for N < 0

$$N = \{(1-\tau_1)(-a_1 + 2b_1 Q_1 + (1+T_1)\pi)$$

$$+ (1-\tau_2)(a_2 - 2b_2 Q_2 - \pi)\}$$

$$/\{(1-\tau_1)2b_1 + (1-\tau_2)2b_2\}$$

Given the way the dynamic program is arranged the quantities

produced, Q_1 and Q_1, are calculated before N is calculated

so the above equation can be used in the program.

In some cases the first calculation will yield a

value of N that is negative and the second a value that is

positive.   In these cases N is set equal to zero.   When

either calculation results in an N of the wrong sign it is

treating the tariff as a subsidy and not as a tax.   When both

equations yield values with the wrong sign it indicates that

trade in either direction will not improve the profit of the

MNC and thus a position of no trade is best for the MNC.

In the dynamic program the net operating income is

calculated after the trade term is calculated.   The appropriate

values are stored by the program.   In the remainder of the

program, single calculations can be used for the variables

calculated.   This occurs because the effect of the difference in

the treatment of the tariff terms is included in the values

calculated and the tariff terms do not appear directly in any of

the calculations used later in the program.

The next step is to consider levels of investment.

This involves examining the operations of the MNC across the time

periods included in the program.   To this end, values for all

possible combinations of capital stock in countries 1 and 2

are calculated.

As discussed in the previous section the dynamic

program requires the input of a set of values to represent the

present value of operations beyond the final time period considered.

This can be arbitrary and in the final periods the program will

show the MNC adjusting to this set of values.   In order to keep

this number of periods small and to avoid having to enter a new

set of values for each program run with different parameter values

the calculation described in the previous section was used to

produce the required set of values.   The equation used is

$$\text{Final Value} = \text{NR} - K_1 \delta_1 q_1 - K_2 \delta_2 q_2$$

In calculating this value there is no need to make fine

adjustments, so possibly more involved calculations were not

considered.

The next stage in the dynamic program is the

calculation of a cost of capital term that includes the tax

variables as specified in section 6.3 of the thesis.   The specific

equation used is

$$\hat{q}_i = q_i(1-g_i)(1-(\tau_i v_i)/(v_i + r(1-\theta_i \tau_i))$$

where

$\hat{q}_i$ = the effective price of capital goods in country i
as defined in section 6.3, represented in the program
as PKi

q_i = the price of capital goods in country i, represented
in the program as PCAPi

g_i = the direct investment grant in country i, as defined
in section 6.3, represented in the program as GRANTi

v_i = the rate of depreciation allowed for tax purposes, as
defined in section 6.3, represented in the program as
DEPTAXi

r = the rate of interest or discount rate, represented
in the program as   R

θ = the term expressing tax on interest income as a
proportion of the profit tax rate, as specified in
section 6.3, represented in the program as PARMTIi

Next a profit value is calculated that takes account of the

investments made in each country.   The equation used is,

$$\text{Profit} = NR - \hat{q}_i I_1 - \hat{q}_2 I_2$$

Then a present value figure is determined. This involves adding current profit to a present value of all future profits. The figure available from the program is a present value figure for the next year which includes in it the profits of all later years already discounted back to that year. Therefore it is sufficient to discount the total figure back for one more year to obtain the appropriate amount. Thus, the equation used is,

$$PV(t) = \text{Profit} + (PV(t+1)/(1+r)$$

Straight line interpolation is used to find values between the points stored in the array. Although the total curve is not linear, enough points are used so that a linear interpolation is satisfactory. The interpolation is used in the calculation going backward through the time periods and in tracing out the optimal path.

Two types of constraints on the level of investment were also considered. These were incorporated by modifying the program and three versions of the program were produced. The investment constraints were designed to limit the investment in any time period to the net operating income of that period. One constraint imposed a penalty that was equal to some proportion of the amount by which the investment exceeded the net operating income. The equation used was

$$\text{Profit} = (1+PENALTY) \cdot \text{Profit}$$

It was only used if a test in the program showed profit for a specific period to be negative. With this equation a penalty value of zero is the same as the no penalty case.

The second constraint was an absolute constraint that did not allow the level of investment to exceed the net operating income. This constraint was incorporated in the program by a test on the profit variable. If its value was negative the levels of investment and resulting present value were not stored in the array of results and the previous value was left. If all values of investment exceed the constraint this would result in unassigned values and would indicate that the same parameters should be used with a smaller grid size.

8.3   CHOICE OF PARAMETER VALUES

As discussed in section 8.1, the dynamic program requires numerical parameter values, and the problem considered here is of the type where illustrative results are to be obtained. In particular the results are to be illustrative of the type of re- sponses or time path that an MNC may follow in a given set of circumstances. To this end a range of values for individual parameters is used in each type of situation considered, instead of using a single value based on some empirical estimate.

The results of the static models discussed in Chapter Five indicate some of the cases that should be considered in the dynamic model, where these cases are defined in terms of

sets of parameter values. One of these cases is one in which

returns to scale depend on the values given to the parameters

of the production function. For the various cases the effect

of variations in other parameter values, such as variations in

tax or tariff rates for a given production function, can be

considered. Chapter Five also indicated cases where the difference

in the rate of profit tax in the two countries, when compared to

the tariff, could be important. The two types of variations in

parameter values, the use of a different value for all time periods

or a change in the value at period 20, and the use of each type

were discussed in section 1 of this chapter.

The choice of values used and any range of variation

for those values depends on a number of considerations. One is

the existence of any limit on the range of permissible values,

such as the limits on the transfer prices discussed in Chapter Five.

Another is to have a substantial overall range of variation while

having close variation around any point that may be an important

change. Such a point is the change from decreasing, to constant,

to increasing returns to scale in production.

The choice of functional forms for the production

functions and demand functions were specified in section 6.2. The

production function has three parameters, A, α, and β. The

parameter A is a scale factor and changes in it can represent

changes in the units of measurement for output, provided the other

parameter values concerned with the same units are also changed.

If the other values are not changed, changes in A represent

changes in the amount of output that can be obtained for any given input. The choice of A is arbitrary and adjusting its value while holding other parameter values constant can be used to obtain results that illustrate specific points. Increasing the difference in the A terms in the two countries can be used to increase the level of trade so that the effect of parameter variations that effect the level of trade is clearer. Decreasing both A terms can reduce the level of profits in order to obtain cases where the effect of the investment constraint will be more pronounced. This use of the A terms will be mentioned further when the results are discussed, and its value is specified when the results are given.

The choice of values used for the α and β terms determine the returns to scale in production. Douglas (1948) provided estimates that can be used as stylized facts in choosing parameter values. A value of α that was one half that of β appeared reasonable, with slight decreasing returns to scale. This ratio of α and β values was used as a starting point for all three types of returns to scale, but variations in this ratio were also considered. The values used are specified when the results are given in Chapter Nine. For decreasing returns to scale the starting point and most common set of values is $\alpha = 0.35$ and $\beta = 0.65$.

Douglas (1948) was a survey of empirical work and serves to illustrate, in principle at least, how the model presented here could be combined with empirical work.

Associated with the production function are parameters giving the wage rate or cost of labour and the cost of capital. Since labour usage is measured in man years a cost that can be interpreted as an annual wage or salary is required. Thus a value that varies around 5000 was used. Capital is measured in pounds sterling. In order to keep the resulting numbers reasonable it was decided to use units of 1000 and thus the cost of capital is 1000. This could be changed to individual units by making a corresponding adjustment to the scale term, A and the results of the program would be identical.

The depreciation function used in the model is a simple exponential rate of decay of the capital stock, as discussed in section 6.2. The rates used here were 10 and 20 per cent. These were not given major consideration in the results produced here and were always made the same in both countries. Depreciation varies more across industries than it does across countries within a single firm so was not considered to be one of the main items to be studied here.

The demand function has two parameters, a and b, intercept and slope. The choice of values for these is arbitrary. In conjunction with the other parameter values they can be varied so that the results illustrate the points being considered. They must be large enough so that it is profitable for the MNC to sell its product in both markets. When the investment constraint is

considered they must also be small enough that the constraint
will have some effect. In addition, the market in country 2
was usually smaller than the market in country 1. This is to
reflect the fact that for most MNC's the host market is smaller
than the home country market. This involves an implicit assump-
tion that country 1 is the home country. This will be further
considered when the results are discussed.

When the results were run the slope term was
usually held constant and had values of 0.2 or 0.3. Changes in
the value of the intercept term were used to change the market
size. The values used are specified when the results are given
but were usually somewhere between 2000 and 4000.

The rates of profit tax used in different countries
cover a wide range and the details of the tax calculations can
differ substantially between countries.[1] The work here is not
concerned with considering tax havens that have very low rates of
tax. It is more concerned with investments in industrialized
countries. As a starting point a tax rate of 50 per cent was used.
Variations above and below this are considered and are used when
the tax rates in the two countries are unequal. The rates used
are specified when the results are given.

Tariffs cover a very wide range depending on the
product imported, and on the country from which it is exported and

---

1. For one survey of actual tax rates and structures see
   Kopits (1976, pp.633-641).

to which it is imported. A range of tariff values was considered including a value of zero and going as high as 60 per cent. For much of the work a value of 30 per cent was used.

The depreciation rate allowed for tax purposes was kept equal to the actual depreciation as specified by another parameter. The use of accelerated depreciation as a tax measure was not considered. Also, the use of the investment grant as a government policy measure was not considered. These could be used to consider possible policies designed to encourage investment in a host country. This is not done here but the possibility is discussed in section 9.4 where possible extensions to and uses of the model are considered.

The provision in the model for a different tax on interest income than on ordinary profits was not used. The model presented here does not include financial variables and does not allow for the use of intra-firm debt by the MNC. It is only when such variables are included that the use of this tax difference could be expected to yield interesting results.

The discount rate was assigned a value of 10 per cent and this was used for all of the results presented. The discount rate is a financial variable and financial questions have not been a concern of this thesis. Thus, the effects of varying the discount rate, or of having it change at an intermediate period, were not explored here.

The choice of value for the transfer price depends on the limits on it discussed in section 6.3. One limit can be

obtained by looking at the prices given as part of the output of the program. The other limit was approximated by calculating the average cost of production in the exporting country. The value used most frequently for the transfer price was 1000. The main variations used were 750, 1250 and 1500, with other values considered if necessary.

When the penalty investment constraint is used values for the penalty are required. A value of zero is the same as no constraint and a sufficiently high value will have the same effect as the absolute constraint. The values used are specified with the results and were from 10 to 40 per cent.

8.4   LISTING OF PROGRAM AND SAMPLE RESULTS

This section includes a listing of the computer program used for the dynamic programming model described in this chapter, and presents one set of results produced by it. The program listing is for the case where there is a penalty constraint on the level of investment. The changes needed for "no constraint" and for the "absolute constraint" are specified below. The no constraint case can also be achieved by using a penalty of zero. The results are for the full time path with decreasing returns to scale in production discussed in Chapter Nine and in Graph 9.1.

To have a program for the no constraint case, line 180 in the program, which imposes the constraint, is removed. For the absolute constraint case line 180 should read,

IF(PROFIT.LT.0) GO TO 11

As a penalty value is not required the references to it in the program can be removed. To do this the phrase ",PENALTY" should be removed from lines 45 and 59, which read in and print out the appropriate line of the input file, and from line 15, which defines the parameters. Line 65 can also have ",IX,F4.1" removed, as the format statement no longer has to allow for the penalty term. The program defines the parameters and variables it uses as real variables and uses double precision arithmetic. The exceptions to this are the integer variables used to control the running of the program and those used in the interpolation process.

A set of results produced by the program is given after the program listing. These are usually printed on continuous folded computer paper, and are divided into sections by printed headings. Here the results have been spread over a number of pages, with some sections being spread over two pages. In particular, the output of the optimal time path has been divided into two parts with its column headings repeated. Normally it appears as one section without these headings being repeated.

The first section of the results "parameter values read in", prints out the parameter values used, in the same format as the input file from which they are read. This allows the runs to be distinguished after they are produced without any further notes being required. In the file, lines one and two give the

first set of parameter values for countries 1 and 2 respectively and lines three and four give the second parameter set for countries 1 and 2 respectively. The order is the same in each line and is as follows: the production function parameters, scale, capital exponent, and labour exponent; the demand function parameters, intercept and slope; the wage rate; the price of capital goods; the depreciation rate; and the tax parameters, the profit tax rate, the tariff, the depreciation rate allowed for tax purposes, the investment grant, and any differential tax rate on interest income. Line five lists the increments used for the grid search, giving values for country 1 and country 2 for the capital stock, labour usage, and investment. Line six gives the discount rate, the initial capital stocks in countries 1 and 2, and the transfer price. Line seven gives the period in which the change is made from the first to the second parameter set and the penalty used in the investment constraint.

The next section of the results "Maximum Net Revenue Values and Associated Values of L1, L2 and N" lists the results of the intermediate calculation. There are two sets of these results, one for each set of parameter values. Each set of results consists of four sets of ten by ten values, giving the net revenue, level of labour usage in countries 1 and 2, and level of trade for each combination of values of the capital stocks used in the grid search. The value of the capital stock

236

for country 1 increases across the rows and the value for country 2 decreases down the colums. This arrangement also holds for the next section of the results, which gives the present values used for the final time period.

The final section gives the values for the optimal time path for the MNC to follow. In the headings the numbers "1" and "2" refer to countries. From left to right these are, the time period, the capital stock, the present value, the level of labour usage, the level of gross investment, the level of trade, and the price and quantity.

```
1    C       DYNAMIC MODEL
2    C       TAX VERSION
3    C       TRANSFER PRICE - IS A PARAMETER
4    C       PARAMETER CHANGES - ONE SET ALLOWED FOR
5            CALL EMASFC('SETMODE',7,'W=132',5)
6    C       SPECIFY VARIABLE TYPES
7            REAL*8SCALE1(2),EXPK1(2),EXPL1(2),SIZE1(2),DECL1(2),WAGE1(2),
8           1  PCAP1(2),DEP1(2),TAX1(2),TARIFF1(2),DEPTAX1(2),GRANT1(2),
9           1  PARMT1(2)
10           REAL*8 SCALE2(2),EXPK2(2),EXPL2(2),SIZE2(2),DECL2(2),WAGE2(2),
11          1  PCAP2(2),DEP2(2),TAX2(2),TARIFF2(2),DEPTAX2(2),GRANT2(2),
12          1  PARMT2(2)
13           REAL*8 K1(10),K2(10),L1(20),L2(20),I1(10),I2(10),NR,
14          1     Q1,Q2,P1,P2,N,R,AK1,AK2,NRA(10,10,4,2),N1,N2,TPRICE
15           REAL*8 MAXV(40,10,10,6),PROFIT,VALUE,PENALTY
16           REAL*8 K10,K20,K1T,K2T,PK1,PK2
17           REAL*8 INCK1,INCK2,INCL1,INCL2,INCI1,INCI2
18           INTEGER KMAX,LMAX,IMAX,TI,TIFINAL,TIPC
19   C       SPECIFY REFERENCE VARIABLES FOR INTEROLATION PROCESS
20           REAL*8 REF1A,REF2A,V1,V2,V3,W(6),W1(6),W2(6)
21           INTEGER REF1B,REF1C,REF2B,REF2C
22   C       SPECIFY GRID SIZES
23           KMAX=10
24           LMAX=20
25           IMAX=10
26           TIFINAL=40
27           WRITE(6,114)
28      114 FORMAT('1')
29           WRITE(6,115)
30           WRITE(6,116)
31      115 FORMAT(6X,'DYNAMIC PROGRAMMING MNC MODEL')
32      116 FORMAT(6X,'PENALTY INVESTMENT CONSTRAINT')
33   C
34   C       READ IN PARAMETER VALUES
35           DO21 J1=1,2
36           READ(1,102)SCALE1(J1),EXPK1(J1),EXPL1(J1),SIZE1(J1),DECL1(J1),
37          1  WAGE1(J1),PCAP1(J1),DEP1(J1),TAX1(J1),TARIFF1(J1),DEPTAX1(J1)
38          1  ,GRANT1(J1),PARMT1(J1)
39           READ(1,102)SCALE2(J1),EXPK2(J1),EXPL2(J1),SIZE2(J1),DECL2(J1)
40          1  ,WAGE2(J1),PCAP2(J1),DEP2(J1),TAX2(J1),TARIFF2(J1),DEPTAX2(J1),
41          1  GRANT2(J1),PARMT2(J1)
42       21 CONTINUE
43   C       READ IN INCREMENT SIZES FOR THE GRID
44           READ(1,103)INCK1,INCK2,INCL1,INCL2,INCI1,INCI2
```

```
45   C       READ IN INTEREST RATE AND INITIAL CAPITAL STOCKS
46           READ(1,104)R,K10,K20,TPRICE
47           READ(1,113)TIPC,PENALTY
48   C
49   C       WRITE BACK VALUES READ IN
50           WRITE(6,101)
51           DO22 J1=1,2
52           WRITE(6,102)SCALE1(J1),EXPK1(J1),EXPL1(J1),SIZE1(J1),DECL1(J1),
53          1  WAGE1(J1),PCAP1(J1),DEP1(J1),TAX1(J1),TARIFF1(J1),DEPTAX1(J1),
54          1  GRANT1(J1),PARMT1(J1)
55           WRITE(6,102)SCALE2(J1),EXPK2(J1),EXPL2(J1),SIZE2(J1),DECL2(J1),
56          1  WAGE2(J1),PCAP2(J1),DEP2(J1),TAX2(J1),TARIFF2(J1),DEPTAX2(J1),
57          1  GRANT2(J1),PARMT2(J1)
58        22 CONTINUE
59           WRITE(6,103)INCK1,INCK2,INCL1,INCL2,INCI1,INCI2
60           WRITE(6,104)R,K10,K20,TPRICE
61           WRITE(6,113)TIPC,PENALTY
62       101 FORMAT(' ',5X,'PARAMETER VALUES READ IN')
63       102 FORMAT(1X,F4.1,1X,2(F3.2,1X),F5.0,1X,F2.1,
64          1 1X,2(F5.0,1X),F2.1,1X,F3.2,1X,F4.2,1X,F2.1,2(1X,F3.1))
65       103 FORMAT(6(1X,F5.0))
66       104 FORMAT(1X,F3.2,2(1X,F6.0),1X,F5.0)
67       113 FORMAT(1X,I2,1X,F7.2,1X,F4.1)
68   C
69   C       CONSTRUCT ARRAYS FOR THE GRID
70           DO1 J1=1,KMAX
71         1 K1(J1)=INCK1*(J1-1)
72           DO2 J2=1,KMAX
73         2 K2(J2)=INCK2*(J2-1)
74           DO3 J3=1,LMAX
75         3 L1(J3)=INCL1*(J3-1)
76           DO4 J4=1,LMAX
77         4 L2(J4)=INCL2*(J4-1)
78           DO5 J5=1,IMAX
79         5 I1(J5)=INCI1*(J5-1)
80           DO6 J6=1,IMAX
81         6 I2(J6)=INCI2*(J6-1)
82   C
83   C       CALCULATION TO FIND THE MAXIMUM OPERATING NET
84   C           REVENUE FOR EACH COMBINATION OF CAPITAL IN
85   C           COUNTRY 1 AND COUNTRY 2
86   C        CONTROL FOR CAPITAL STOCK 1 AND CALCULATE AK1
87           DO23 J8=1,2
88           DO7 J1=1,KMAX
89           AK1=SCALE1(J8)*K1(J1)**EXPK1(J8)
90   C       CONTROL FOR CAPITAL STOCK 2 AND CALCULATE AK2
91           DO7 J2=1,KMAX
92           AK2=SCALE2(J8)*K2(J2)**EXPK2(J8)
```

```
93    C      SET INITIAL VALUES OF THE NET REVENUE ARRAY
94           NRA(J1,J2,1,J8)=-10**6
95    C      CONTROL FOR LABOUR USED IN 1 AND CALCULATE QUANTITY
96    C          PRODUCED IN COUNTRY 1
97           DO7 J3=1,LMAX
98           Q1=AK1*L1(J3)**EXPL1(J8)
99    C      CONTROL FOR LABOUR USED IN 2 AND CALCULATE QUANTITY
100   C          PRODUCED IN COUNTRY 2
101          DO7 J4=1,LMAX
102          Q2=AK2*L2(J4)**EXPL2(J8)
103   C      CALCULATE OPTIMUM TRADE BETWEEN THE TWO PARTS OF
104   C          THE FIRM AND IMPOSE CONSTRAINTS
105   C      CALCULATION DEPENDS ON THE SIGN OF N
106          N1=(1-TAX1(J8))*(-SIZE1(J8) +2*DECL1(J8)*Q1)
107        1 +(1-TAX2(J8))*(+SIZE2(J8) -2*DECL2(J8)*Q2)
108          N2=2*((1-TAX1(J8))*DECL1(J8) +(1-TAX2(J8))*DECL2(J8))
109          N=(N1+(1-TAX1(J8))*TPRICE -(1-TAX2(J8))*(1+TARIFF2(J8))*TPRICE)/N2
110          IF(N.GT.0) GO TO 31
111          N=(N1+(1-TAX1(J8))*(1+TARIFF1(J8))*TPRICE -(1-TAX2(J8))*TPRICE)/N2
112          IF(N.GT.0) N=0
113       31 CONTINUE
114          IF(N.GT.Q1) N=Q1
115          IF(N.LT.-Q2) N=-Q2
116   C      CALCULATE PRICES AND NET REVENUE
117          P1=SIZE1(J8) -DECL1(J8)*(Q1-N)
118          P2=SIZE2(J8) -DECL2(J8)*(Q2+N)
119          IF(N.GE.0) NR=(1-TAX1(J8))*(P1*(Q1-N) -WAGE1(J8)*L1(J3) +TPRICE*N)
120        1 +(1-TAX2(J8))*(P2*(Q2+N) -WAGE2(J8)*L2(J4) -(1+TARIFF2(J8))
121        1 *TPRICE*N)
122          IF(N.LT.0) NR=(1-TAX1(J8))*(P1*(Q1-N) -WAGE1(J8)*L1(J3)
123        1 +(1+TARIFF1(J8))*TPRICE*N) +(1-TAX2(J8))*(P2*(Q2+N) -WAGE2(J8)
124        1 *L2(J4) -TPRICE*N)
125   C      CHECK FOR MAXIMUM NET REVENUE
126          IF(NR.LT.NRA(J1,J2,1,J8)) GO TO 7
127          NRA(J1,J2,1,J8)=NR
128          NRA(J1,J2,2,J8)=L1(J3)
129          NRA(J1,J2,3,J8)=L2(J4)
130          NRA(J1,J2,4,J8)=N
131        7 CONTINUE
132   C      WRITE RESULTS OF MAXIMIZATION OF NET REVENUE
133          WRITE(6,109)
134          WRITE(6,106)
135          DO8 J7=1,4
136          WRITE(6,109)
137          DO8 J2=1,KMAX
138        8 WRITE(6,105)(NRA(J1,J2,J7,J8),J1=1,KMAX)
139       23 CONTINUE
140      106 FORMAT(' ','MAXIMUM NET REVENUE VALUES AND ASSOCIATED',
141        1 ' VALUES OF L1, L2 AND N')
142      105 FORMAT(10(1X,F10.0))
143      109 FORMAT(' ')
```

```
144   C
145   C      CALCULATE MAXIMUM PRESENT VALUE FOR ALL TIME PERIODS
146   C         FOR EACH CAPITAL STOCKS COMBINATION AND STORE RESULTS
147   C      CALCULATION OF PRESENT VALUES FIGURES FOR
148   C         FINAL TIME PERIOD AND WRITE RESULTS
149   C      FINAL PERIOD USES THE SECOND PARAMETER SET
150          DO9 J1=1,KMAX
151          DO9 J2=1,KMAX          \
152          MAXV(TIFINAL,J1,J2,1)=NRA(J1,J2,1,2) -K1(J1)*DEP1(2)*PCAP1(2)
153         1 -K2(J2)*DEP2(2)*PCAP2(2)
154        9 CONTINUE
155          WRITE(6,109)
156          WRITE(6,112)
157          DO16 J2=1,KMAX
158       16 WRITE(6,105)(MAXV(TIFINAL,J1,J2,1),J1=1,KMAX)
159      112 FORMAT(' ',5X,'PRESENT VALUES FOR THE FINAL PERIOD')
160   C
161   C      ESTABLISH INDEX FOR TIME PERIODS
162          TI=TIFINAL
163          J9 = 2
164       10 IF(TI.EQ.1) GO TO 12
165          TI=TI-1
166          IF(TI.LT.TIPC) J9=1
167   C      CONTROL FOR CAPITAL STOCKS 1 AND 2 AND SET INITIAL
168   C         VALUES OF PRESENT VALUE ARRAY
169          PK1=PCAP1(J9)*(1-GRANT1(J9))*(1-((TAX1(J9)*DEPTAX1(J9))/(DEPTAX1
170         1 (J9)+R*(1-PARMT1(J9)*TAX1(J9)))))
171          PK2=PCAP2(J9)*(1-GRANT2(J9))*(1-((TAX2(J9)*DEPTAX2(J9))/(DEPTAX2
172         1 (J9)+R*(1-PARMT2(J9)*TAX2(J9)))))
173          DO11 J1=1,KMAX
174          DO11 J2=1,KMAX
175          MAXV(TI,J1,J2,1)=-10**6
176   C      CONTROL FOR LEVELS OF INVESTMENT IN COUNTRY 1 AND 2
177          DO11 J5=1,IMAX
178          DO11 J6=1,IMAX
179   C      CALCULATE PROFIT FOR EACH TIME PERIOD FOR EACH
180   C         COMBINATION OF K1, K2, I1, AND I2
181          PROFIT=NRA(J1,J2,1,J9) -PK1*I1(J5) -PK2*I2(J6)
182          IF(PROFIT.LT.0) PROFIT=(1+PENALTY)*PROFIT
183   C      DETERMINE CAPITAL STOCKS FOR NEXT PERIOD
184          K1T=K1(J1)*(1-DEP1(J9)) +I1(J5)
185          K2T=K2(J2)*(1-DEP2(J9)) +I2(J6)
```

```
186   C         INTERPOLATION TO FIND PRESENT VALUE FROM NEXT PERIOD
187             REF1B=(K1T/INCK1)+1
188             REF1A=(K1T/INCK1)+1-REF1B
189             REF1C=REF1B+1
190             IF(REF1B.GT.KMAX-1) REF1C=KMAX
191             IF(REF1B.GT.KMAX-1) REF1B=KMAX
192             REF2B=(K2T/INCK2)+1
193             REF2A=(K2T/INCK2)+1-REF2B
194             REF2C=REF2B+1
195             IF(REF2B.GT.KMAX-1) REF2C=KMAX
196             IF(REF2B.GT.KMAX-1) REF2B=KMAX
197   C         INTERPOLATION CALCULATION OF PRESENT VALUE
198             V1=MAXV((TI+1),REF1B,REF2B,1)*(1-REF1A)
199            1 +MAXV((TI+1),REF1C,REF2B,1)*REF1A
200             V2=MAXV((TI+1),REF1B,REF2C,1)*(1-REF1A)
201            1 +MAXV((TI+1),REF1C,REF2C,1)*REF1A
202             V3=(V1*(1-REF2A))+V2*REF2A
203   C         CALCULATION OF PRESENT VALUE AND COMPARISON
204   C            FOR A MAXIMUM
205             VALUE=PROFIT +V3/(1+R)
206             IF(VALUE.LT.MAXV(TI,J1,J2,1)) GO TO 11
207             MAXV(TI,J1,J2,1)=VALUE
208             MAXV(TI,J1,J2,2)=NRA(J1,J2,2,J9)
209             MAXV(TI,J1,J2,3)=NRA(J1,J2,3,J9)
210             MAXV(TI,J1,J2,4)=I1(J5)
211             MAXV(TI,J1,J2,5)=I2(J6)
212             MAXV(TI,J1,J2,6)=NRA(J1,J2,4,J9)
213          11 CONTINUE
214   C         START CALCULATION FOR NEXT TIME PERIOD
215             GO TO 10
216   C
217   C         OUTPUT OPTIMAL PATH
218   C         SET INITIAL POSITION
219          12 CONTINUE
220             K1T=K10
221             K2T=K20
222             TI=0
223   C         OUTPUT INITIAL TIME PERIOD
224             WRITE(6,109)
225             WRITE(6,107)
226             WRITE(6,108)
227         107 FORMAT(' ',10X,'OPTIMAL TIME PATH VALUES')
228         108 FORMAT(' ','TI',5X,'K1',7X,'K2',8X,'PV',8X,'L1',
229            1 5X,'L2',4X,'I1',5X,'I2',9X,'N',8X'P1',7X,'Q1',7X,
230            1 'P2',7X,'Q2')
```

242

```
231   C      RE SET TIME PERIOD
232          J9 = 1
233       13 TI=TI+1
234          IF(TI.GE.TIPC) J9=2
235   C      DETERMINE GRID POSITION AND INTERPOLATE REQUIRED VALUES
236          REF1B=(K1T/INCK1)+1
237          REF1A=(K1T/INCK1)+1-REF1B
238          REF1C=REF1B+1
239          IF(REF1B.GT.KMAX-1) REF1C=KMAX
240          IF(REF1B.GT.KMAX-1) REF1B=KMAX
241          REF2B=(K2T/INCK2)+1
242          REF2A=(K2T/INCK2)+1-REF2B
243          REF2C=REF2B+1
244          IF(REF2B.GT.KMAX-1) REF2C=KMAX
245          IF(REF2B.GT.KMAX-1) REF2B=KMAX
246   C      CALCULATION OF VALUES
247          DO14 J8=1,6
248          W1(J8)=MAXV(TI,REF1B,REF2B,J8)*(1-REF1A)
249        1 +MAXV(TI,REF1C,REF2B,J8)*REF1A
250          W2(J8)=MAXV(TI,REF1B,REF2C,J8)*(1-REF1A)
251        1 +MAXV(TI,REF1C,REF2C,J8)*REF1A
252          W(J8)=W1(J8)*(1-REF2A) +W2(J8)*REF2A
253       14 CONTINUE
254   C      CALCULATE P1, Q1, P2, AND Q2
255          Q1=SCALE1(J9)*K1T**EXPK1(J9)*W(2)**EXPL1(J9)
256          Q2=SCALE2(J9)*K2T**EXPK2(J9)*W(3)**EXPL2(J9)
257          P1=SIZE1(J9)-DECL1(J9)*(Q1-W(6))
258          P2=SIZE2(J9)-DECL2(J9)*(Q2+W(6))
259   C      PRINT OUT VALUES
260          WRITE(6,111)TI,K1T,K2T,W(1),W(2),W(3),W(4),
261        1 W(5),W(6),P1,Q1,P2,Q2
262      111 FORMAT(I3,2X,2(F7.0,2X),F10.0,2X,4(F5.0,2X),F9.0,
263        1 4(2X,F7.0))
264   C      DETERMINE K1 AND K2 FOR NEXT PERIOD
265          K1T=K1T*(1-DEP1(J9))+W(4)
266          K2T=K2T*(1-DEP2(J9))+W(5)
267   C       CHECK IF FINAL PERIOD TREACHED
268          IF(TI.EQ.TIFINAL-1) GO TO 15
269          GO TO 13
270       15 CONTINUE
271          STOP
272          END
```

```
DYNAMIC PROGRAMMING MNC MODEL
PENALTY INVESTMENT CONSTRAINT
PARAMETER VALUES READ IN
5.0 .30 .65 4000. .3 5000. 1000. .2 .40 0.00 .2 0.0 1.0
4.5 .30 .65 2000. .3 5000. 1000. .2 .50 0.00 .2 0.0 1.0
5.0 .30 .65 4000. .3 5000. 1000. .2 .40 0.00 .2 0.0 1.0
4.5 .30 .65 3000. .3 5000. 1000. .2 .50 0.00 .2 0.0 1.0
900.  300.   80.   40.  330.  110.
.10 5000.    800. 1000.
20    0.00
```

MAXIMUM NET REVENUE VALUES AND ASSOCIATED VALUES OF L1, L2 AND N

```
      0.  3141719.  3975288.  4487968.  4863338.  5155594.  5393040.  5591455.  5760999.  5911361.
1750838.  3522799.  4197354.  4649653.  4989176.  5257670.  5476230.  5664497.  5826676.  5967542.
2418016.  3760251.  4356290.  4767036.  5082926.  5333732.  5541681.  5717493.  5873143.  6008963.
2839061.  3949880.  4488935.  4870055.  5161499.  5400875.  5598701.  5770068.  5916915.  6047318.
3148284.  4107742.  4601839.  4956786.  5235557.  5460387.  5648496.  5811272.  5955624.  6081057.
3392201.  4249176.  4704948.  5038482.  5298074.  5515289.  5698032.  5852955.  5991540.  6112560.
3592888.  4370440.  4794898.  5108520.  5359995.  5564636.  5740830.  5893035.  6026026.  6145176.
3762685.  4481682.  4880522.  5178178.  5415822.  5613539.  5779033.  5928078.  6056537.  6173660.
3909232.  4582626.  4956461.  5239987.  5465781.  5657622.  5820094.  5961068.  6085770.  6199000.
4037609.  4673800.  5025943.  5295445.  5515800.  5697553.  5857252.  5994374.  6115652.  6223601.

   0.   880.   880.   960.   960.   960.   960.   960.   880.   880.
   0.   640.   800.   800.   880.   880.   880.   880.   880.   880.
   0.   560.   720.   800.   800.   800.   800.   880.   800.   800.
   0.   480.   640.   720.   720.   800.   800.   800.   800.   800.
   0.   400.   560.   640.   720.   720.   800.   800.   800.   800.
   0.   400.   560.   640.   720.   720.   720.   720.   720.   720.
   0.   400.   480.   640.   640.   720.   720.   720.   720.   720.
   0.   320.   480.   560.   640.   640.   640.   720.   720.   720.
   0.   320.   480.   560.   560.   640.   640.   640.   720.   720.
   0.   320.   400.   560.   560.   640.   640.   640.   640.   640.
```

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
760.	240.	160.	120.	80.	80.	80.	40.	40.	40.
760.	360.	240.	160.	160.	120.	120.	80.	80.	80.
760.	440.	320.	240.	200.	160.	120.	120.	120.	80.
760.	520.	400.	320.	240.	200.	160.	120.	120.	120.
760.	560.	400.	320.	240.	240.	200.	160.	160.	160.
760.	600.	480.	360.	320.	240.	200.	200.	160.	160.
760.	640.	480.	400.	320.	280.	240.	200.	200.	160.
760.	680.	520.	400.	360.	280.	280.	240.	200.	160.
760.	680.	560.	400.	360.	320.	280.	240.	240.	200.

0.	0.	150.	563.	791.	983.	1149.	1296.	1243.	1358.
-1857.	-878.	-284.	26.	444.	625.	782.	992.	1118.	1234.
-2287.	-1326.	-601.	-97.	105.	340.	487.	876.	809.	918.
-2582.	-1632.	-916.	-424.	-172.	226.	447.	578.	696.	887.
-2815.	-1938.	-1233.	-753.	-284.	-58.	335.	546.	664.	773.
-3010.	-2060.	-1291.	-803.	-326.	-168.	42.	242.	353.	454.
-3179.	-2178.	-1612.	-913.	-672.	-204.	10.	132.	325.	426.
-3330.	-2431.	-1663.	-1183.	-711.	-492.	-289.	104.	214.	402.
-3466.	-2543.	-1771.	-1223.	-994.	-525.	-397.	-205.	188.	379.
-3590.	-2596.	-2038.	-1261.	-1029.	-631.	-427.	-232.	-129.	51.

MAXIMUM NET REVENUE VALUES AND ASSOCIATED VALUES OF L1, L2 AND N

0.	3260522.	4370329.	5073741.	5581524.	5974650.	6292283.	6557007.	6785548.	6983382.
1750838.	3761685.	4685975.	5301789.	5755742.	6114465.	6410168.	6657677.	6870877.	7056134.
2418423.	4095312.	4908953.	5466080.	5885619.	6222796.	6499120.	6736118.	6937855.	7116988.
2851794.	4362681.	5094032.	5606204.	5997740.	6315198.	6579051.	6803135.	6998277.	7169844.
3182797.	4586234.	5254114.	5729576.	6098878.	6397828.	6646995.	6863797.	7051450.	7217379.
3453134.	4781275.	5395023.	5839112.	6187871.	6473160.	6714178.	6920960.	7100629.	7261717.
3682811.	4945803.	5521465.	5940481.	6271180.	6543378.	6772851.	6972515.	7148205.	7303960.
3883109.	5092164.	5638033.	6031781.	6346820.	6608092.	6829750.	7021053.	7190321.	7340829.
4061071.	5222727.	5743045.	6118541.	6418841.	6667786.	6882284.	7069209.	7233174.	7378531.
4221413.	5339655.	5840876.	6196219.	6484255.	6726524.	6931600.	7112452.	7272140.	7415239.

0.	1040.	1200.	1280.	1280.	1280.	1280.	1200.	1200.	1200.
0.	880.	1040.	1120.	1200.	1200.	1200.	1120.	1120.	1120.
0.	720.	960.	1040.	1120.	1120.	1120.	1120.	1120.	1120.
0.	640.	880.	960.	1040.	1040.	1040.	1040.	1040.	1040.
0.	560.	800.	880.	960.	960.	960.	1040.	1040.	1040.
0.	560.	720.	880.	880.	960.	960.	960.	960.	960.
0.	560.	720.	800.	880.	880.	960.	960.	960.	960.
0.	480.	640.	720.	800.	880.	880.	880.	960.	960.
0.	480.	640.	720.	800.	800.	880.	880.	880.	880.
0.	480.	560.	720.	720.	800.	800.	880.	880.	880.

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
760.	320.	240.	160.	120.	80.	80.	80.	80.	40.
760.	520.	360.	240.	200.	160.	120.	120.	120.	80.
760.	640.	440.	320.	280.	240.	200.	160.	160.	120.
760.	720.	520.	400.	320.	280.	240.	200.	160.	160.
760.	760.	600.	440.	400.	320.	280.	240.	200.	200.
760.	760.	600.	480.	400.	360.	280.	240.	240.	200.
760.	760.	680.	560.	440.	360.	320.	320.	240.	200.
760.	760.	680.	560.	480.	440.	360.	320.	280.	280.
760.	760.	760.	600.	520.	440.	400.	320.	280.	280.

0.	707.	1381.	1842.	2117.	2347.	2547.	2564.	2718.	2859.
-1857.	28.	751.	1281.	1726.	2006.	2198.	2203.	2350.	2556.
-2251.	-513.	391.	965.	1404.	1674.	1922.	2085.	2232.	2440.
-2386.	-862.	85.	652.	1083.	1343.	1580.	1802.	1943.	2144.
-2492.	-1164.	-220.	338.	820.	1072.	1301.	1691.	1904.	2033.
-2580.	-1297.	-525.	222.	496.	960.	1191.	1407.	1613.	1735.
-2657.	-1374.	-591.	-34.	445.	689.	1151.	1371.	1504.	1703.
-2726.	-1565.	-897.	-352.	180.	647.	872.	1012.	1472.	1674.
-2787.	-1627.	-954.	-403.	72.	306.	765.	976.	1177.	1293.
-2844.	-1683.	-1264.	-511.	-197.	266.	482.	944.	1148.	1263.

PRESENT VALUES FOR THE FINAL PERIOD

0.	3080522.	4010329.	4533741.	4861524.	5074650.	5212283.	5297007.	5345548.	5363382.
1690838.	3521685.	4265975.	4701789.	4975742.	5154465.	5270168.	5337677.	5370877.	5376134.
2298423.	3795312.	4428953.	4806080.	5045619.	5202796.	5299120.	5356118.	5377855.	5376988.
2671794.	4002681.	4554032.	4886204.	5097740.	5235198.	5319051.	5363135.	5378277.	5369844.
2942797.	4166234.	4654114.	4949576.	5138878.	5257828.	5326995.	5363797.	5371450.	5357379.
3153134.	4301275.	4735023.	4999112.	5167871.	5273160.	5334178.	5360960.	5360629.	5341717.
3322811.	4405803.	4801465.	5040481.	5191180.	5283378.	5332851.	5352515.	5348205.	5323960.
3463109.	4492164.	4858033.	5071781.	5206820.	5288092.	5329750.	5341053.	5330321.	5300829.
3581071.	4562727.	4903045.	5098541.	5218841.	5287786.	5322284.	5329209.	5313174.	5278531.
3681413.	4619655.	4940876.	5116219.	5224255.	5286524.	5311600.	5312452.	5292140.	5255239.

OPTIMAL TIME PATH VALUES

TI	K1	K2	PV	L1	L2	I1	I2	N	P1	Q1	P2	Q2
1	5000.	800.	52243061.	800.	132.	1283.	293.	373.	2623.	4962.	1649.	798.
2	5283.	933.	52598976.	799.	130.	1076.	196.	403.	2609.	5040.	1631.	827.
3	5302.	942.	52670414.	799.	130.	1062.	189.	404.	2608.	5045.	1629.	831.
4	5303.	943.	52727946.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
5	5304.	943.	52789828.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
6	5304.	943.	52857805.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
7	5304.	943.	52932574.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
8	5304.	943.	53014818.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
9	5304.	943.	53105288.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
10	5304.	943.	53204804.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.

TI	K1	K2	PV	L1	L2	I1	I2	N	P1	Q1	P2	Q2
11	5304.	943.	53314272.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
12	5304.	943.	53434686.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
13	5304.	943.	53567142.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
14	5304.	943.	53712844.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
15	5304.	943.	53873116.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
16	5304.	943.	54049415.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
17	5304.	943.	54243344.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
18	5304.	943.	54456665.	799.	130.	1061.	189.	404.	2608.	5046.	1629.	831.
19	5304.	943.	54691319.	799.	130.	2051.	739.	404.	2608.	5046.	1629.	831.
20	6294.	1493.	56066389.	962.	239.	1325.	335.	1412.	2626.	5993.	2151.	1418.
21	6360.	1530.	55293173.	960.	238.	1276.	308.	1417.	2624.	6004.	2148.	1422.
22	6364.	1531.	54365807.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
23	6364.	1531.	53341057.	960.	237.	.1273.	306.	1417.	2623.	6006.	2148.	1422.
24	6364.	1531.	52213590.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
25	6364.	1531.	50973363.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
26	6364.	1531.	49609112.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
27	6364.	1531.	48108436.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
28	6364.	1531.	46457693.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
29	6364.	1531.	44641875.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
30	6364.	1531.	42644476.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
31	6364.	1531.	40447337.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
32	6364.	1531.	38030484.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
33	6364.	1531.	35371945.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
34	6364.	1531.	32447553.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
35	6364.	1531.	29230721.	960.	237.	1273.	306.	1417.	2623.	6006.	2148.	1422.
36	6364.	1531.	25692206.	960.	237.	306.	511.	1417.	2623.	6006.	2148.	1422.
37	5378.	1736.	21200550.	960.	280.	2.	0.	1159.	2633.	5716.	2159.	1644.
38	4320.	1388.	15886270.	950.	318.	0.	0.	925.	2684.	5310.	2222.	1670.
39	3456.	1111.	10449108.	971.	319.	0.	0.	824.	2736.	5038.	2284.	1564.

248

Chapter Nine

R E S U L T S   O F   T H E   D Y N A M I C

P R O G R A M M I N G   M O D E L

.

.

CHAPTER NINE

R E S U L T S O F T H E D Y N A M I C P R O G R A M M I N G

M O D E L

The results of the dynamic programming version of

the MNC model are in the form of a time path, over 39 periods,

of levels of capital stock, investment, and labour usage in each

country, and the level and direction of trade between the two

countries, where these are chosen by the MNC.   Also given are

the quantities produced and the prices charged in each country,

which depend on the levels of the above mentioned variables and

in turn influence the choice of the level for those variables.

This time path depends on the parameter values used and upon any

changes in those values during the time periods considered.   In

the first section descriptions of three time paths are given,

one for each of the decreasing, constant, and increasing returns

to scale in production cases.

The results to be considered can be broken down into

a number of cases, but the categories used may not be mutually

exclusive.   The divisions can depend on: the types of variations

in parameter values considered;   the types of constraints put

on the time path, such as constraints on the level of investment;

and on combinations of selected parameters, such as those giving

the returns to scale in production.   In this chapter the cases
will be considered in the following way.   First, variations in
the values given to selected individual parameters for all time
periods will be considered.   This will be done only for parameters
which it is appropriate to consider individually and each set of
variations will be done for a number of combinations of other
parameters.   Next, changes in the value of an individual parameter
or a set of parameters at period 20 will be considered, both for
the case of no investment constraint and for the case of an
investment constraint.   This corresponds to the comparative static
results, but instead of just considering the new equilibrium
position the time path by which it is reached will also be
considered.   This section will be divided into three groups of
results where these are defined by the returns to scale in
production specified by the parameters.

The chapter will conclude by looking at a number of
the possible extensions that could be made to the model.

A large number of computer runs were required to
produce the results reported here.   Not all of the runs are
reported in full detail, not only would this require large amounts
of space, but it is not the most appropriate way of comparing
different runs when the values of selected parameters, or the
investment constraint, are being varied.   Also, some runs done to
check extreme cases are noted, but are not reported in detail.

The general description of the time path that
results from the dynamic program is given for three cases, one
for each of the decreasing, constant and increasing returns to
scale in production cases.   The parameter values used for these
results are generally from the middle of the range of variations
considered later.   No investment constraint is included in the
results presented here.   The results are presented graphically
in this section and in the rest of the chapter.

The time path can be divided into two sets of periods,
a set where the values of the variables are changing from one
period to the next, and a set where the values of the variables
stay the same from one period to the next.   The first set
constitutes an adjustment phase and the second set constitutes a
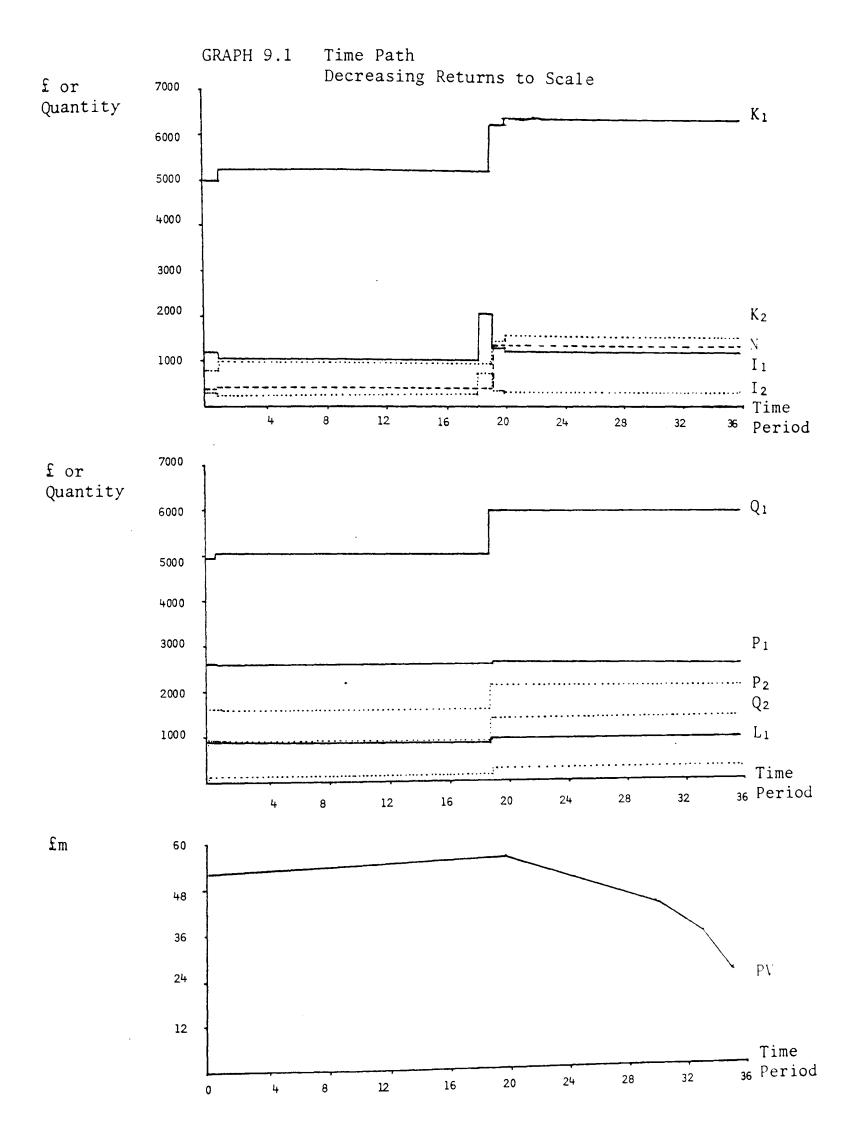stationary phase.

A stationary phase is associated with a set of
periods when the parameter values are constant and the MNC has
adjusted its capital stock in each country to those parameter
values.   Thus, the levels of capital stock will remain constant.
Investment will be used to replace depreciation so will remain
constant, with net investment equal to zero.   Labour usage in
each country will also remain constant as the same level will be
appropriate in each period.

The adjustment phase occurs when the MNC has some
reason to change either its capital stock or its level of labour

usage in either or both countries. There are three reasons
why this can occur in the model. The main one of interest is
when there is a change in the set of parameter values at some
period. Another occurs for the first few periods as the initial
capital stock assigned with the parameter set may not be the one
that is appropriate to those parameter values. This phase can
be reduced or eliminated by changing the initial capital stocks
specified. The third occurs in the final few time periods. As
discussed in Chapter Eight, the program requires that a set
of values, representing the present value for future time periods,
be used in the program. As the values used do not represent a
continuation of the final set of parameters the MNC will adjust its
capital stock and labour usage to the final period value. This
is not a problem as the number of time periods is sufficient that
the last few periods can be disregarded. Since no parameter
values can be associated with the final value used there is no way
to interpret this adjustment phase. These have been omitted from
the graph of the full time path and the stationary values have been
extended to period 36 with periods 37 to 39 being omitted.

The stationary phase can be related to the
equilibrium position in comparative static analysis. The adjustment
phase is the process of moving from one equilibrium position to
another that is not considered in static analysis.

The time path for the case of decreasing returns to
scale in production is given in Graph 9.1. In this case there is
production in both countries and trade between the countries, going

GRAPH 9.1   Time Path
            Decreasing Returns to Scale

£ or Quantity

K_1

K_2

N

I_1

I_2

Time Period

£ or Quantity

Q_1

P_1

P_2

Q_2

L_1

Time Period

£m

PV

Time Period

254

from country 1 to country 2. With production in both countries
there is a capital stock, a level of investment, and a level of
labour usage in each country.

The production function parameters can be the same
or different in the two countries. In the case presented the
scale term is different, but the exponents are the same, with the
production function in county 1 being $5.0K^{.30}L^{.65}$ and in
country 2 being $4.5^{.30}L^{.65}$. With the difference in the production
functions there is a shift in production towards the more
efficient country. The shift is not complete due to decreasing
returns. As the returns in the more efficient country become
smaller it eventually becomes appropriate to split the production.
If the difference in efficiency is large, or the total quality
produced small a concentration of production in one country may
occur. Such results were produced in some of the computer runs
not reported here.

The rate of profit tax can also be the same or
different in the two countries. Where they are identical there
is no incentive to shift profits in order to reduce taxes. Where
they are different the appropriate shifting of profits can affect
taxes paid. In the model both production costs and income can be
shifted. Moving production from one country to the other while
using trade to maintain the same distribution of sales will do
this. The shifting of production causes the shift in costs.
The use of trade shifts income through the use of the transfer

price. The higher the transfer price the more income that is moved. Any tariff on imports will combine with the transfer price to impose a cost (a tax) on the use of trade. If the amount of production costs shifted exceeds the income shifted, production will move to the high tax country and reduce profits and taxes there. If the amount of income shifted exceeds the amount of production costs shifted, production will move to the low tax rate country and increase profits there. This shifting of production is discussed further when transfer price and other parameter variations are considered.

In the run presented the rates of profit tax are different and equal 40 per cent in country 1 and 50 per cent in country 2. As discussed in Chapter Six, with the tax assumptions used this implies that country 1 is the home country.

In the run presented there is a difference in the size of the markets in the two countries, with the market in country 1 being larger than that in country 2. The size of the market in country 1 is constant for all time periods with a price intercept of 4000 and a slope of 0.3. The size of the market in country 2 increases in period 20 with the intercept equal to 2000 before that and 3000 after, while the slope is always equal to 0.3. The difference in the market sizes results in the difference in the two prices with P1 greater than P2.
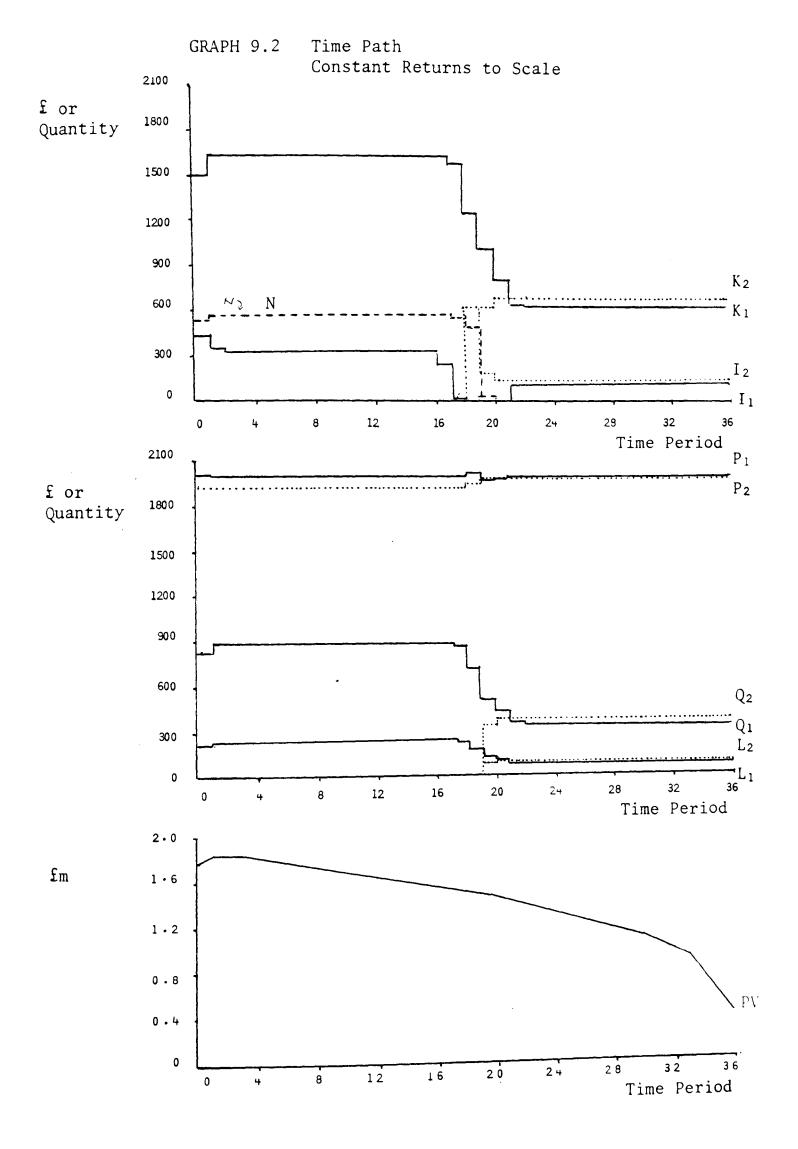
The change in the market size at period 20 results in a change in all variables. There is an increase in sales in country 2 made up partly from local production and partly from an

increase in imports in country 1. The increase in production in country 1 changes the marginal costs and this leads to a decrease in sales and increase in price in country 1. This price change is much smaller than the change in country 2. The increase in production leads to an increase in capital stock and in labour used. The levels of investment show a large jump at period 20 in order to increase the capital stocks. The levels of investment then fall back to the level required to meet the depreciation from the increased capital stock.

The new investment here occurs almost all in one period. This is due to the lack of any constraint on the level of investment. In a later section two alternative constraints on the level of investment will be considered. These have the effect of increasing the number of periods over which the adjustment of the capital stocks take place.

The change in the parameter set at period 20 results in two stable time paths being produced. In the next section, where individual parameter values are varied for all time periods, two observations are obtained from each computer run.

The time path for the case of constant returns to scale in production is presented in Graph 9.2. There are considerable differences between the parameters used in this case from those used in the decreasing returns to scale case. Here the production functions in both countries are the same and are $2.0K^{.35} L^{.65}$. The market size is the same in both countries

GRAPH 9.2   Time Path
            Constant Returns to Scale

£ or
Quantity

£ or
Quantity

£m

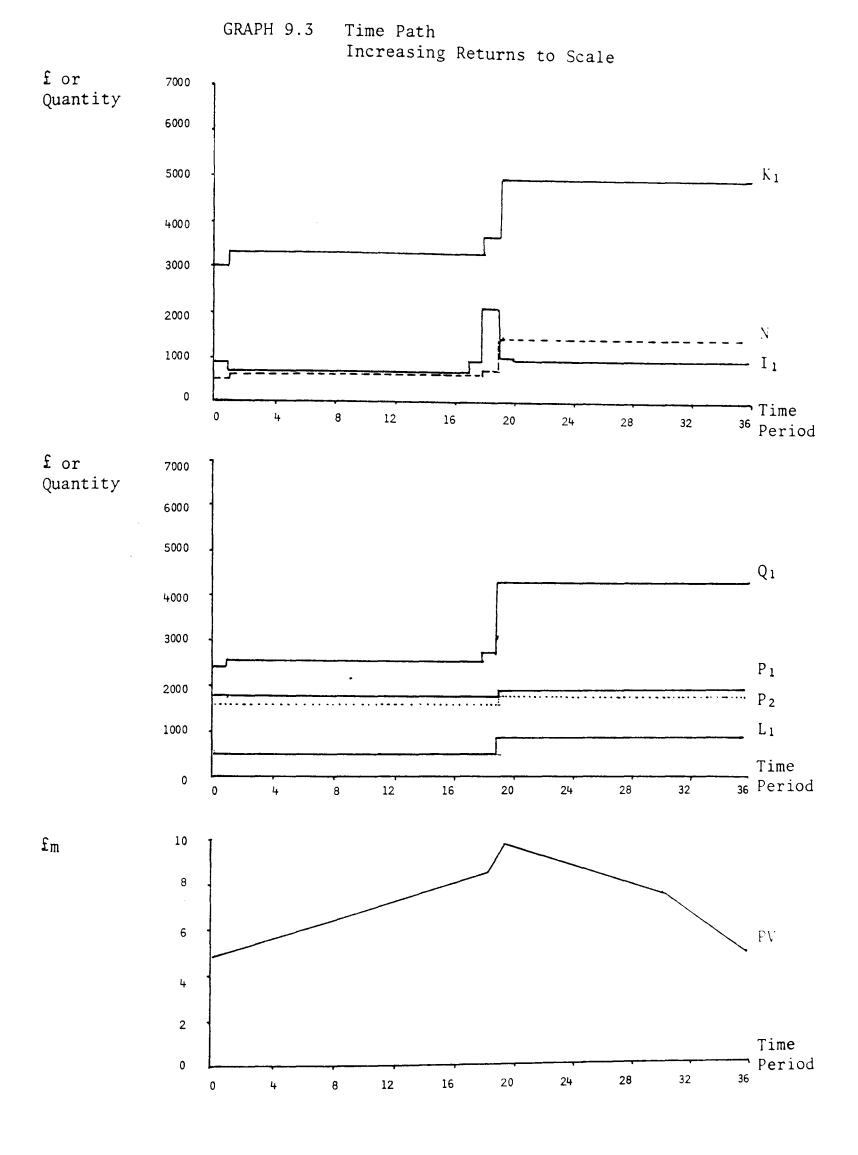and remains constant, with a price intercept of 2100 and a slope of 0.3.

In the constant returns to scale case, with equal production functions and costs of inputs, production can be either consolidated in one country or split between the two countries. The choice will depend on any difference in the rates of profit tax and on the rates of tariffs on imports. This is the case illustrated here. The profit tax rate is greater in country 1 than in country 2 with rates of 50 per cent and 40 per cent respectively. The tariff is zero in periods 1 to 19 and is 20 per cent in periods 20 to 39.

In the first set of periods, all production is concentrated in the high tax country which is the host country given the tax assumptions used. This increases the production costs incurred there more than it increases the income there so reducing the total tax bill. In the second set of periods production is split between the two countries and there is no trade. This change occurs because the increased tariff costs now exceed the savings on profit taxes. Sales are slightly higher and price slightly lower in the low tax country for both situations. Sales in the exporting country remain constant when the tariff is introduced but decline in the importing country. These differences reflect the inclusion of tax and tariff terms in the first order conditions, which were obtained for the static case, with decreasing returns to scale, in Chapter Five.

In the constant returns to scale case a situation where there is production in both countries and trade will not occur, except during an adjustment phase. Since negative investment is not allowed the capital stock can only be reduced by depreciation with zero gross investment. During the period when the capital stock in country 1 is declining it can pay the MNC to continue to use it and to export to country 2, while also maintaining production in country 2. This is not an equilibrium position and the trade eventually falls to zero. Such a situation only exists for two periods in the case illustrated. It may be longer when an investment constraint is included, or when the capital stock must decline to a much greater extent than in the case considered here.

The time path for the increasing returns to scale in production case is given in Graph 9.3. In the case illustrated the production functions are equal and are $1.0K^{.35} L^{.80}$. The market size in country 1 is larger than the market in country 2 and both of these increase at period 20. For country 1 the intercept terms are 2100 and 2400 and for country 2 they are 1750 and 2000. For both countries and for all time periods the slope equals 0.2.

In the increasing returns to scale case production tends to be concentrate in one country in order to take advantage of the returns to scale. In the case illustrated the rates of profit tax are equal at 50 per cent. The tariff on imports are

GRAPH 9.3   Time Path
            Increasing Returns to Scale

the same for both countries at 20 per cent.   The presence

of tariffs causes production to be located in the country with

the larger market so as to reduce the amount traded.   Changes

in parameter values can alter this result and very high tariffs

can result in production in both countries.   This is considered

in the next section.

The quantities sold and prices are greater in

country 1 than in country 2, due to the larger market size in

country 1.   The adjustment of the capital stock to the increased

market size again takes place in one period because there is no

constraint on the level of investment.   The effects of two

alternative constraint are considered later.

The run illustrated here is used as a starting

point for variation in the transfer price level and in the tariff

level with increasing returns to scale, which is considered in the

next section.

9.2   VARIATIONS IN PARAMETER VALUES

This section is concerned with the effect on the

results of changing the value assigned to an individual parameter

for all time periods.   This variation involves running the program

using three or four values for the parameter under consideration,

while holding the rest of the parameter set constant across all

the runs.   In looking at the results only the changes in the

stable path phases of the results are considered.   The adjustment

phases are the concern of the next section. They involve alternative constraints on the level of investment, and it is better to consider the two types of results separately.

The variations in parameter values were considered separately for each of the three types of returns to scale in production. This is necessary because the importance of the changes in the values of some of the parameters depends on the type of returns to scale being considered. In particular, how changes in the values of some parameters effect the level of trade is strongly influenced by the type of returns to scale.

For each parameter whose value is being varied the total number of possible combinations of values of the remaining parameters that could be considered is large. In order to keep the number of results considered within reasonable bounds only certain possible combinations were considered.

The first parameter to be considered is the transfer price. When there is trade between the two countries the level of the transfer price influences the amount of the MNC's income that is shifted from the importing country to the exporting country, thus influencing the amount that must be paid due to profit taxes in each country and due to tariffs in the importing country. If there are no tariffs and the rate of profit tax is the same in both countries the transfer price will have no effect on the results. The choice of transfer price values to be used is discussed in section 8.3 and is indicated on the graphs presented here.

Transfer price variations with decreasing returns to scale in production will be considered first. In order to ensure that production occurred in both countries and that trade took place between them, production fuctions were chosen with the scale term being larger in country 1 than in country 2. The market size was larger in country 1 than in country 2 and a change in the market size in country 2 at period 20 was used to obtain two stable paths.
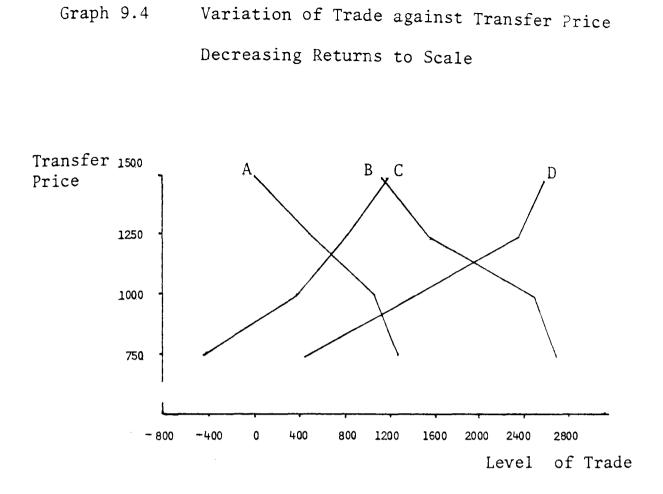
There are two situations to be considered here. One where the rates of profit taxes are equal and there is a positive tariff on imports, and a second where the rates of profit taxes are different and the tariff on imports is zero. The results are illustrated in Graph 9.4, with lines A and B illustrating the first situation and lines C and D the second. The graph shows how the level of trade changes as the value of the transfer price changes. The associated changes in the values of other variables are discussed below.

In the first situation the production function for country 1 is $6.0K^{.30} L^{.65}$ and for country 2 is $4.0K^{.30} L^{.65}$. The market size defined by the intercept term in country 1 is 4000 and in country 2 is 2000 for periods 1 to 19 and 3000 for periods 20 to 39. The rates of profit tax are 50 per cent and the tariff is 30 per cent and is the same for both countries.

With a positive tariff, increases in the transfer price will increase the amount of import duties payable, and this

causes trade to decline, as illustrated by lines A and B in
Graph 9.4. With the profit taxes equal there is no other effect
to offset the reduction in trade. The decline in trade will
stop when trade reaches zero and is independent of the initial
direction of trade. The decline in trade is accompanied by
a shift in production from the exporting to the importing
country with total production decreasing only slightly, in this
case by less than 5 per cent, as the transfer price increases
over the full range considered. There was an increase in sales
and fall in price in the exporting country and a decrease in
sales and an increase in price in the importing country. With
decreasing returns to scale the reduction in the quantities produced
results in more efficient production and leads to a decrease in
price. With falling exports, domestic sales can be increased
while production is declining. In the importing country the
increase in production leads to a higher price and with the decline
in imports to lower sales. The present value of the firm also
declined. This is due to the shift to less efficient production
and to the higher import duties paid.

In the second situation the production function in
country 1 is $5.0K^{.30} L^{.65}$ and for country 2 is $4.5K^{.30} L^{.65}$.
The market sizes are the same as for the first case. The rate
of profit tax in country 1 is 40 per cent and in country 2 is
50 per cent. The tariffs on imports are equal to zero for
both countries.

265

Graph 9.4   Variation of Trade against Transfer Price

Decreasing Returns to Scale

Notes.

1. Trade is due to a difference in the values of the scale
    factors in the production functions in the two countries.
2. Line B has larger trade values than line A because the
    market size in country 2 is larger in case B.
3. For lines A and B the profit tax rates are equal and the
    tariff on imports is positive.
4. For lines C and D the profit tax rates are different and
    the tariff on imports equals zero.

In this situation changes in the transfer price effect

the amount of income moved from the importing to the exporting

country by the MNC.   The amount of income moved relative to the

amount of production costs moved due to trade will determine where

the production should be located in order to minimize the taxes

paid by the MNC.   Changing the transfer price will change these

relative amounts.   If the amount of income moved due to trade

exceeds the amount of production costs moved, trade will flow

from the low tax country country to the high tax country in

order to minimize the taxes paid on the income.   If the

production costs moved exceed the income moved, trade will flow

from the high tax country to the low tax country country in order

to gain the maximum advantage from the tax deduction allowed for

the costs of production.

In the cases illustrated by lines C and D in

Graph 9.4 there is a reversal of the direction of trade when the

transfer price is increased from £750 to £1000.   This represents

a change from exporting from the high tax country to exporting from

the low tax country.   As the transfer price is increased further

the amount of trade increases and further advantage is taken of

the low tax rate.   The presence of decreasing returns to scale in

production prevents a complete shift of all production to one

country or the other.   Increasing production in one country results

in increasing costs due to the effect of decreasing returns to

scale.   Production will be shifted to the point where the increases

in costs are equal to the tax saving.   In the cases illustrated

the total quantity produced increased as the transfer price was

increased.   Sales in the high tax country increased as price

decreased and in the low tax rate country decreased as price

increased.   This reflects the changes in production costs that

occur under decreasing returns to scale when the quantity produced

changes which was discussed for the previous situation.

In this second situation the present value of the MNC increased as the transfer price increased thus indicating that this is a situation in which the MNC would desire a high rather than a low transfer price.
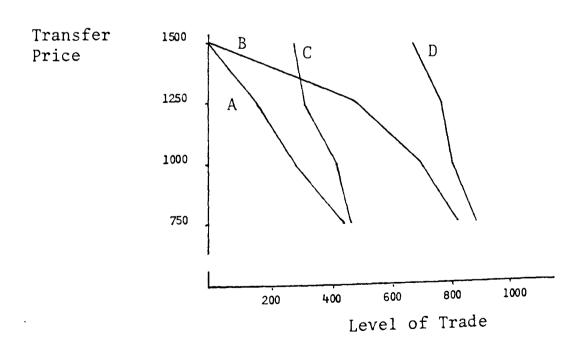
With decreasing returns to scale in production the shifts in production are gradual. This will not hold when cases of constant and increasing returns to scale are considered.

Conflicting results due to an increase in the transfer price have been observed, with trade either increasing or decreasing. A variety of cases could be considered including cases with a difference in the rates of profit taxes and a positive tariff on imports. If an actual policy change were being considered the parameter values could be estimated and used in the model to obtain some estimate of the responses of the MNC's. Since a very large number of combinations of parameter values are possible further cases will not be considered here and attention will be given to cases involving constant and increasing returns to scale in production.

To consider transfer price variations with constant returns to scale two situations were again considered; one where the rates of profit taxes are equal and tariffs on imports are positive and a second where the rates of profit taxes are different in the two countries and there are no tariffs on imports. In the first situation it was necessary to use unequal production functions in order to achieve reasonable levels of trade over the range of transfer prices considered.

With constant returns to scale the costs of
production do not depend on the level of production. If these
costs are equal in the two countries any costs of trade are
sufficient to cause there to be no trade with local production
being used to serve each market. With unequal costs of
production, however, all production will take place in the low
cost country and the second market will be served by exports
provided the difference in the costs of production exceeds the
costs of trade. When the costs of trade exceed the difference
in the costs of production there will be no trade and each market
will be served by local production. This is the case illustrated
in Graph 9.5 by lines A and B.

Graph 9.5   Variation of Trade against Transfer Price

Constant Returns to Scale

Notes.

1.   For lines A and B trade is due to a difference in the scale
      factor in the production functions in the two countries.
2.   For lines C and D trade is due to a difference in the rate
      of profit tax in the two countries.

269

In the first situation the production function in country 1 is $2.5K^{.35} L^{.65}$ and in country 2 is $2.0K^{.35} L^{.65}$. The market size in both countries increases at period 20 for country 1 from 2400. to 2700. and for country 2 from 2000. to 2250. The rate of profit tax equals 50 per cent for both countries and the tariff on imports equals 30 per cent for both countries.

The sales in the exporting country should remain constant as changes in the level of production have no effect on costs and this was found in the results, although there were slight variations in this quantity from one transfer price level to the next with the direction of change not being consistent. This could probably be eliminated if a finer grid size was used in the dynamic program but would not appear to be worth the costs and computer time required. ·

The sales in the importing country decline as imports decline until local production is started. As the costs of importing increased, the quantity sold is reduced and the price increased. The curves should show an abrupt fall to zero at the changeover point, and the exact point at which this occurs could be obtained by trying more transfer price values. For line B this point should be near a transfer price of £1250. as the results obtained showed both trade and local production of 86 units in the importing country. This indicates that the costs of trade and the costs of local production are equal at this point.

In the second situation with constant returns to scale the production functions in the two countries are identical and are $2.0K^{.35}L^{.65}$. The market sizes are the same as in the first of these two situations. The rate of profit tax in country 1 is 50 per cent and in country 2 is 40 per cent. The tariffs on imports for both countries are equal to zero.

In this situation production takes place in the high tax country and the low tax country is served by exports. The level of trade shows a slow decline as the transfer price is increased. There is a decline in sales and an increase in price in the importing country. Increasing the price in the importing country increases the fraction of income that is subject to tax at the lower rate of the importing country for any given transfer price. Thus, the after tax revenue is not independent of the price in the importing country and the increase of price results in a shift in the revenue curve that benefits the MNC. In the exporting country there is no change in the quantity sold or the price. Higher transfer prices than those reported here were considered and it was found that a switch of production to the low tax country occurred at a transfer price of about £1750. The present value of the MNC was lowest at the transfer price where the switch in production occurred and increased as the transfer price moved in either direction from that point.

The results concerning the present value correspond with those reported in Chapter Five where the MNC will choose the minimum or the maximum allowable transfer price, depending upon
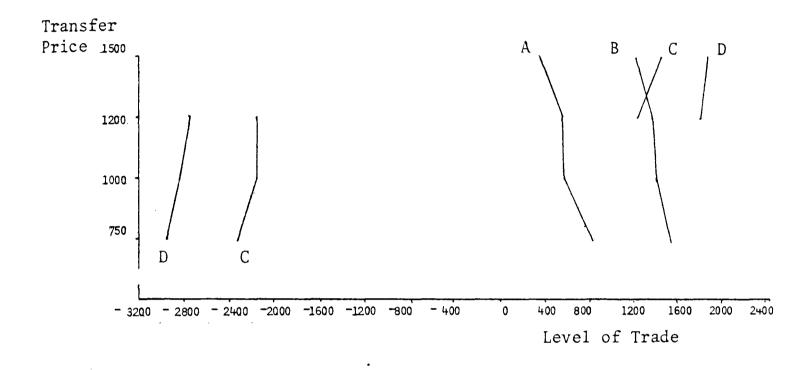
the situation, but will not choose an intermediate value for the price. The Chapter Five result, however, involved decreasing returns to scale, not the constant returns to scale considered here.

For transfer price variations with increasing returns to scale in production two cases are again considered. In the first case the rates of profit tax are equal at 50 per cent and the tariff on imports is positive and equals 20 per cent. The market size in both countries increases in period 20 and in country 1 grows from 2100 to 2400 and in country 2 from 1750 to 2000. In this case the production functions are identical, and are $1.0K^{.35} L^{.80}$. This is illustrated as lines A and B in Graph 9.6. There is a concentration of production in country 1. The increase in the transfer price increases the costs due to import tariffs and this is reflected in the fall in the level of trade. Since there is no production in country 2 this also represents a fall in the level of sales in country 2. The increase in trade costs are not sufficient to cause production in both countries but such a case is shown when the variations in the level of the tariff are considered. The decline in sales in country 2 is equal to the decline in the level of trade and results in an increase in the price in country 2.

In the second case the rates of profit tax are different in the two countries and equal 40 per cent in country 1 and 50 per cent in country 2. The tariff rate equals zero for

both countries.   The production function and market sizes are

the same as in the first case.   This is illustrated as lines C

and D in Graph 9.6.

Graph 9.6   Variation of Trade against Transfer Price

Increasing Returns to Scale.

Transfer
Price

Level of Trade

Notes.

1.   Trade is due to the concentration of production due to
     increasing returns to scale.
2.   Line B has larger trade values than line A because the
     market size in country 2 is larger in case B.
3.   Lines C and D are discontinuous due to the reversal of the
     direction of trade and the location of production.

The case considered here also illustrates a point

about the initial capital stocks that are assumed.   With

increasing returns to scale all production will be concentrated

in one country.   One country will result in the maximum profit

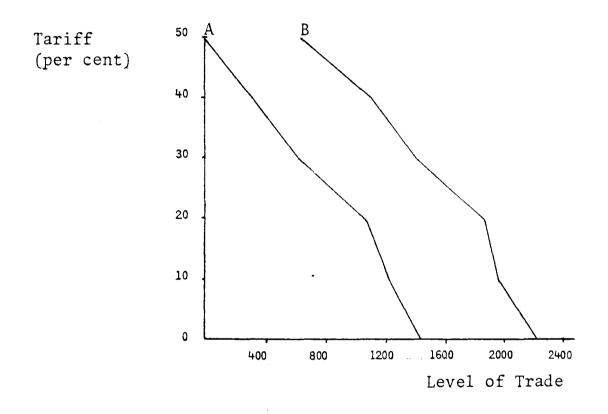for the MNC but if the initial values assumed have the capital

stock in the other country it may not pay the firm to switch to the other country. Lines C and D illustrate this situation. For transfer price values of £750 and £1500 the MNC will switch production between countries to achieve maximum profits. For values of £1000 and £1250 the MNC will maintain production in whichever country possesses the initial capital stock, as the costs of switching the location of production exceed the increase in profits. Part of this is due to the assumption that the existing capital stock cannot be sold but can only be reduced by depreciation. This is considered further when the adjustment process is considered in the next section.

Variations in the level of the tariffs on imports were also considered. Again cases of decreasing, constant, and increasing returns to scale were considered. The cases considered involved equal rates of profit tax in the two countries. In this situation increasing the tariff with a constant transfer price increases the costs of trade and the results are basically the same as those obtained for transfer price increases where the rates of profit tax are equal and the tariffs are positive. Here, however, a zero tariff, and tariffs high enough to stop all trade can be considered. Tariffs are also instruments of government policy and can be varied directly, while the choice of transfer price by the MNC can be limited, but can not be directly controlled, by the government.

With decreasing returns to scale, increases in the tariff reduce the level of trade. This is shown in Graph 9.7.

The trade is due to unequal production functions, for country 1, $6.0K^{.30}L^{.60}$ and for country 2, $4.0K^{.30}L^{.60}$. The market size in country 1 is 4000 and in country 2 is 2500 for periods 1 to 19 (case A) and 3000 for periods 20 to 39 (case B). The profit tax rates are equal at 50 per cent.

Graph 9.7   Variation of Trade against the Tariff
              Decreasing Returns to Scale

Notes.

1. Trade is due to a difference in the value of the scale factor in the production functions in the two countries.
2. Line B has larger trade values than line A because the market size in country 2 is larger in case B.
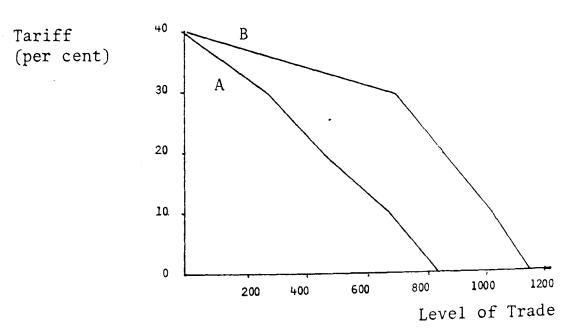
For case A the increase in the tariff was sufficient to eliminate all trade. This was not so for case B, but further increases in the tariff could have achieved the same result. The

change in the tariff had little effect on the prices and quantity sold in the exporting country. This has been discussed when the corresponding transfer price variation was considered. An increase in sales and a decrease in price is expected, and would show up more strongly if the returns to scale were more strongly decreasing.

For both cases there is a fall in the quantity sold in the importing country as the tariff is increased, accompanied by a rise in the price and an increase in the quantity produced locally. Thus, in the situation described the importing country can use tariff increases to encourage the replacement of imports with local production, but will impose a cost of higher prices and decreased sales on local customers.

In considering changes in the level of tariffs on imports with constant returns to scale in production, distinct production fuctions in the two countries were used in order to have trade between the countries. The same production functions and market sizes were used as for the case of transfer price variation with constant returns to scale and equal rates of profit taxes (Graph 9.5, lines A and B). In the case considered here the transfer price is set at £1000 and the tariff is varied instead of setting a tariff equal to 30 per cent and varying the transfer price. Increasing the tariff, like increasing the transfer price, increases the costs of trade, and the same type of results were found. With a low tariff production is concentrated in the more

efficient country. When the tariff is increased above a level
such that the costs of import duties exceeds the difference in the
production costs in the two countries, trade will stop and local
production will start in the high cost country. This occurs at a
tariff of 40 per cent as illustrated in Graph 9.8. The price and
the quantity sold in the exporting country remain constant while in
the importing country the quantity sold decreases and the price
increases. This change in quantity sold and price in the importing
country stops when local production is started. Thus, the import-
ing country can again use tariff increases to cause the MNC to switch
from imports to local production while again incurring an increase
in local prices. This result depends on the presence of non-
increasing returns to scale. When the increasing returns to scale
case is considered a result is obtained where increases in the
tariffs result in imports falling to zero but local production is not
started and the MNC withdraws from the market.

Graph 9.8   Variation of Trade against the Tariff
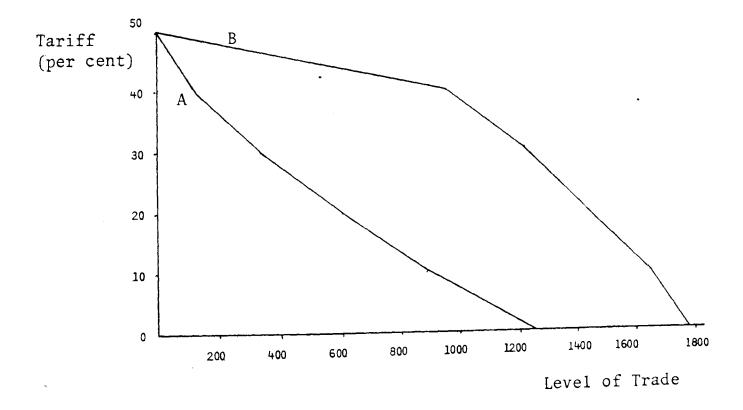
            Constant Returns to Scale

Notes.

1.   Trade is due to a difference in the scale factor in the
      production functions in the two countries.

277

With increasing returns to scale, production is
usually concentrated in one country.   Increasing the level of
tariffs can reduce the quantity imported to the second country.
At a sufficiently high tariff level imports will cease and either
sales of the good in the importing country will cease or local
production will start.   These situations are illustrated as
cases A and B in Graph 9.9.   The production functions and market
sizes are the same as for the variation in the transfer price with
increasing returns to scale and equal profit taxes (Graph 9.6,
lines A and B).

Graph 9.9   Variation of Trade against the Tariff

Increasing Returns to Scale

Notes.

1.   Trade is due to the concentration of production due to
     increasing returns to scale.

278

When imports are being used, as the tariff increases
the quantity sold in the importing country decreases, the price
increases, and there is a fall in the quantity produced in the
exporting country.

In case A when trade falls to zero the MNC withdraws
from the host country market. This indicates that the host
country market is too small for production serving that market
alone to be profitable.

In case B, when there was a switch to local production
the quantity sold in the importing country increased from the
quantity imported at the next lower tariff level, specifically to
1543 from 958. This reduced the fall in the quantity sold, and
the increase in the price, that occurred from the zero tariff
level. The falls in quantity were 15.1 and 45.8 per cent and
the increases in price were 3.2 and 9.8 per cent. This situation
reflects a delay in cutting back production in the exporting
country in order to retain advantages of large scale there. Once
the change to production in both countries occurs the increase in
sales in the host country reflects the increasing returns to scale
in production there. In case B the present value declined as the
tariff increased and continued to decrease when the change from
trade to local production occurred. This further reflects the
loss due to decreased scale that occurs when production is split.

Variations in the values of some parameters have been
considered here and there are a number of additional parameters for

which such variations could be considered. These include variations in the exponent terms of the production functions for given returns to scale, the wage rate, the price of capital goods, the depreciation rate, and the discount rate. A large number of computer runs would be required to consider all of these. It would be more appropriate to develop these when specific policy proposals or questions are to be considered. This could be combined with the empirical estimation of the parameter values as discussed in the next section.

9.3   ADJUSTMENT PATHS AND INVESTMENT CONSTRAINTS

The adjustment process and the effects on it of the introduction of constraints on the level of investment in any one time period remain to be considered. The adjustment process takes place when there is a change in the parameters of the model that the MNC is subject to. This is usually in period 20 of the computer run and what is reported is the adjustment from the previous stable path to the new stable path. This takes place between periods 16 and 25 and only these periods are reported here. Parameter changes can be of two types: one where the parameter change is anticipated; and one where the change is not anticipated. The first of these is represented in the model when the parameter set is changed at period 20. The second is represented by two runs of the model. In the first run the initial stable path is obtained, and in the second run the initial capital stocks are taken from the

first run stable path and the second set of parameter values is used. The adjustment phase starts in the first period of this run.

The effects of the parameter changes can be divided into two groups, those where the capital stock in one or both countries is increased and there is no decrease in either capital stock and those where one or both capital stocks are reduced by depreciation.

The investment constraints being used were discussed in Chapter Eight. They are of two types: an absolute constraint, where the investment expenditure in any period must be financed from the net revenue of the MNC in that period; and a penalty constraint, where the expenditure on investment can exceed the net revenue of the same period but a penalty equal to some proportion of this excess must be paid by the MNC. It may be possible to interpret this penalty as the costs of using external sources of finance, but this will depend in part on the level of penalty required to have any effect on the investment expenditures. The levels of penalties used in the cases considered below were chosen to give results that were between those given by no constraint and the absolute constraint. It was found that a strong enough penalty will give the same results as the absolute constraint.

The adjustment process will first be considered using constant returns to scale in production. Two cases will be considered. Both start with production concentrated in one country and trade used to serve the market in the second country.
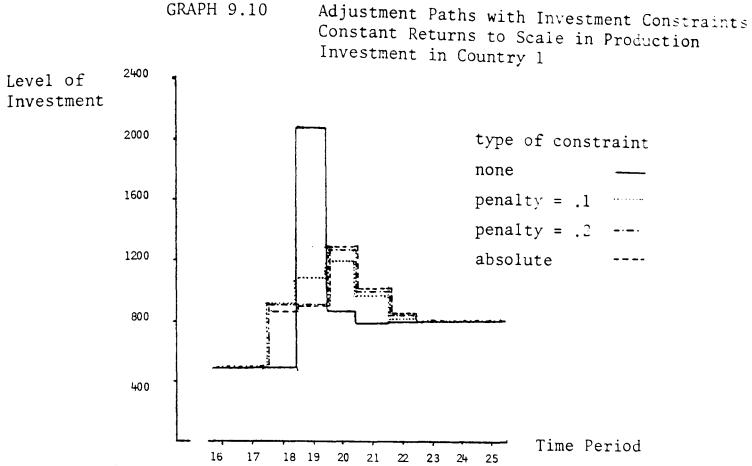
In the first case an increase in the size of both markets causes the adjustment and it results in an increase in the capital stock in the one country. In this case the adjustment path for both an anticipated and an unanticipated change is considered. In the second case a change in the tariffs on imports in the importing country causes the adjustment and it results in a change to production in both countries with no trade, which requires a decrease in one capital stock and an increase in the other capital stock. Only the response to an anticipated change is considered in this case.

In the first case the market size in country 1 goes from 2400 to 2700 and in country 2 from 2000 to 2250. The production function is the same in both countries and is $2.0K^{.35} L^{.65}$. The rates of profit tax are unequal and are 50 per cent in country 1 and 40 per cent in country 2. The tariffs on imports are equal to zero for both countries. The difference in profit tax rates causes the concentration of production, in this case in the high tax country. Thus, all production and investment occurs in country 1, with none in country 2, so only the graph for country 1 is required to present the results.

The results for the first case where the parameter change is anticipated are illustrated in Graph 9.10. Two penalty functions were used and had values of 10 and 20 per cent. In the model, before and after the adjustment the level of investment will be sufficient to replace depreciation from the capital stock. This is illustrated by the values of investment

for the end periods of the graph. The values for the last periods are higher than the values for the first periods as the capital stock has been increased. In the case where there is no investment constraint the entire adjustment takes place in one period. This is in period 19 which is the period before the parameter change and thus the increased capital stock is available as soon as it is required. When an investment constraint is imposed the adjustment is spread over more periods. It starts one period sooner in period 18 and reaches its maximum in period 20, the period when the parameter change has become effective. The more important the constraint is the less of the adjustment that takes place before period 20 and the more of the adjustment that takes place in or after period 20. This reflects the fact that the increased market size increases the revenue of the firm and provides more funds from which to finance the investment.
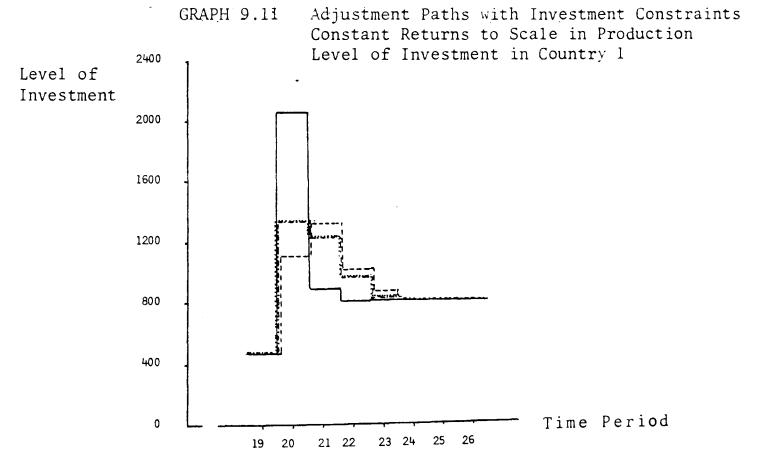
When the parameter change is not anticipated the adjustment process will not start until after the changes takes place, that is in period 20 in the model considered here. The results for this case are illustrated in Graph 9.11. Where there is no investment the full adjustment again takes place in one period, but here it is in period 20 and not in period 19. That is after, instead of before, the parameter change. When investment constraints are imposed, again using penalties of 10 and 20 per cent, the adjustment is spread over a number of periods but does not start before period 20. When the penalty function is used the

GRAPH 9.10   Adjustment Paths with Investment Constraints
               Constant Returns to Scale in Production
               Investment in Country 1

Notes:
1. The adjustment is due to an increase in the size of the markets in
    both countries.
2. The change in the market size is anticipated by the MNC.

GRAPH 9.11   Adjustment Paths with Investment Constraints
               Constant Returns to Scale in Production
               Level of Investment in Country 1

Notes:
1. The adjustment is due to an increase in the size of the markets in
    both countries.
2. The change in the market size is not anticipated by the MNC.

284

peak of the investment curve is in period 20 but when the absolute constraint is used the peak occurs in period 21. The present value figures were also looked at, and the stronger the constraint the lower these are.

The fact that it is useful to correctly anticipate the parameter change is shown by the fact that the MNC will chose to make part or all of its adjustment before the change if it knows about the change in advance. It should be recalled that the model is dealing with changes that are known with certainty as uncertainty is not included in the model.

For the investment constraint to be effective the level of investment must exceed the net operating income of the same period. Some runs were produced where this was not the case and the investment constraints had no effect.

With a constraint, the capital stock is reduced, from what it would be without the constraint, during those periods over which the adjustment-making investment is spread. For these periods production is reduced and price therefore increased. That there is a loss of profit is shown by the faster adjustment used in the no-constraint case, and by the higher level of capital stock maintained when the stable path is reached. The per period profit, once the stable path is reached, is independent of any constraint.

With the penalty investment constraint the MNC is making a choice between reducing the costs of investment and foregoing potential profits in the next period. The higher the penalty the more profits it pays the firm to forego in order to

reduce the costs of rapid investment.   This is shown in the results by the increase in the adjustment periods as the penalty is increased.
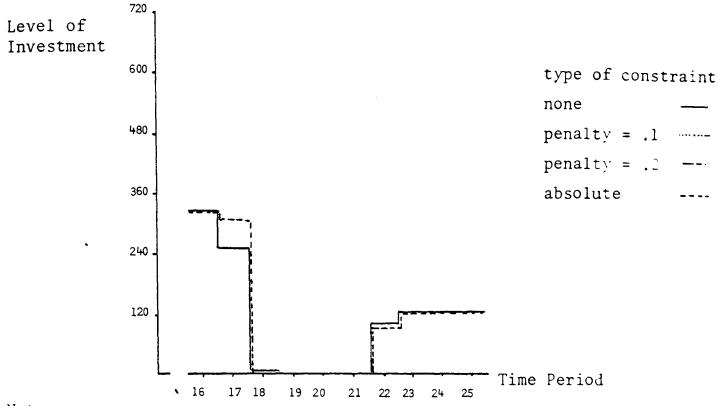
With an absolute constraint, the MNC is no longer making a choice, but simply must keep investment within what it can finance internally, whatever the loss of profits.

In the second case with constant returns to scale in production a tariff increase in period 20 causes a switch from concentrating production in country 1 and serving country 2 by trade to having production in both countries with no trade. Only an anticipated parameter change is considered in this case. The market size remains constant and is the same for both countries at 2100.   The production function is the same in both countries and is $2.0K^{.35} L^{.65}$.   The rates of profit tax are unequal and are 50 per cent in country 1 and 40 per cent in country 2.   Tariffs on imports are zero for periods 1 to 19 and 20 per cent for periods 20 to 39.

The difference in the rates of profit taxes causes the initial concentration of production in country 1.   With the increase in tariffs the costs of trade exceed the profit tax saving of trade so split production results.   The time path of investment in both countries is illustrated in Graph 9.12 a and b.
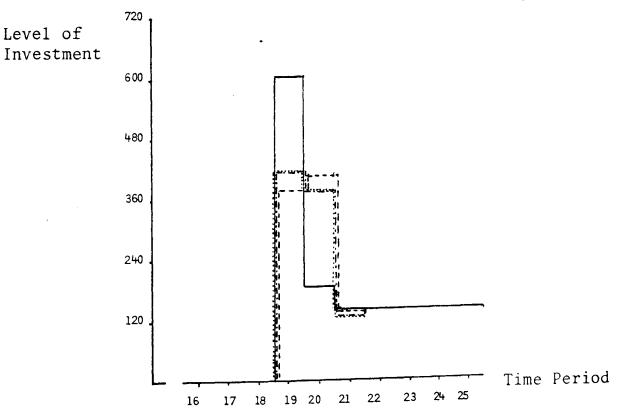
In this case the MNC will want to reduce the capital stock in country 1 after period 19.   As the model does not allow for the sale of capital stock (or negative investment) this reduction can only take place through depreciation of the existing

GRAPH 9.12   Adjustment Paths with Investment Constraints
              Constant Returns to Scale in Production

a.   Investment in Country 1

Note:
1. In this case the time paths for no constraint and a penalty of .1
   are identical and those for a penalty of .2 and the absolute
   constraint are identical

b.   Investment in Country 2

Notes:
1. The adjustment is due to an increase in tariffs in Country 2,
      the importing country.
2. The change is not anticipated by the MNC.

287

capital stock. This leads to the period of zero investment in country 1. As there is still production in country 1 positive investment starts again, in period 22, after the capital stock has fallen to the desired level in order to maintain that level of capital stock. The period of zero investment was the same for all investment constraints and was almost the same when there was no constraint. In country 2 no capital stock is required until period 20. Investment starts in period 19 to have the capital stock in place for period 20. Most of the adjustment takes place in period 19 with a small part of it taking place in period 20, and trade stops in period 21 when there is no constraint on the level of investment. The spreading of the adjustment over two periods is due to the time it takes for the capital stock in country 1 to decline in size. With the investment constraints the adjustment is spread almost evenly between periods 19 and 20 but still takes only two periods.
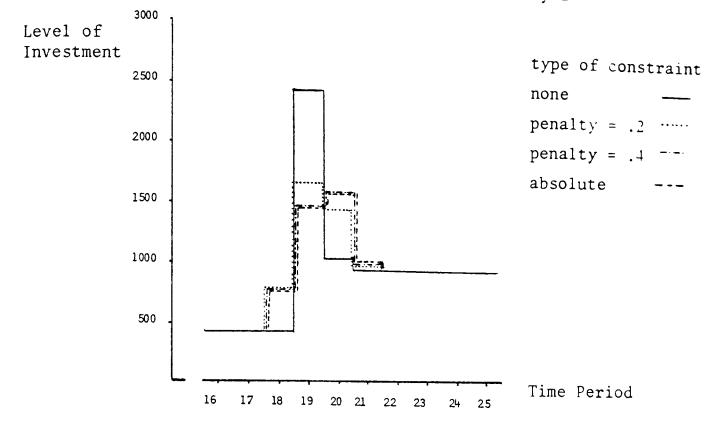
The use of a tariff increase to encourage local production was discussed in the previous section. This section shows that the effect of such a policy can be fairly quick and if it is sufficiently anticipated local production will start as soon as the tariff increase becomes effective. For an unanticipated change the delay in response in the previous case was one period (year). This result partly depends on the omission from the model of any time required to design and install new capital.
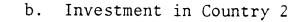
The effects of the investment constraints when there is decreasing returns to scale in production were considered for a
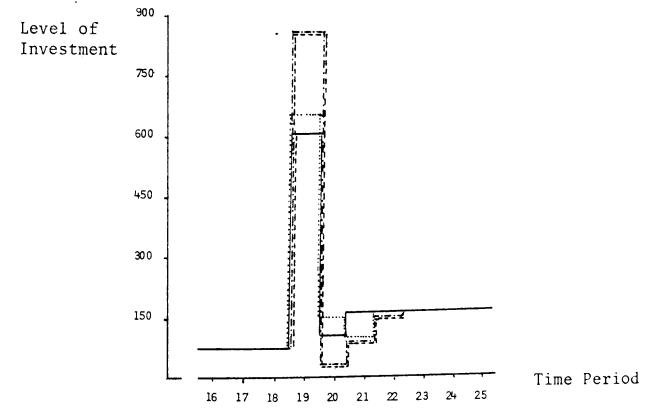
a parameter change anticipated by the MNC. The parameter change
is an increase in the market size in both countries, going from
2400 to 3200 in country 1 and from 1600 to 2400 in country 2.
The production function for country 1 is $5.0K^{.30} L^{.65}$ and for
country 2 is $4.5K^{.30} L^{.65}$. The rate of profit tax equals
40 per cent in country 1 and 50 per cent in country 2, and the
tariffs are equal to zero.

In the case being considered there is production in
both countries and trade between them. The increase in the market
sizes results in an increase in the capital stocks in both
countries which is achieved by increased investment in both
countries. The investment paths are given in Graph 9.13 a and b,
and are similar to that given in Graph 9.10. With no investment
constraint the adjustment in both countries is concentrated in
period 19 so that the increased capital stocks are in place for
period 20 when they are required. The penalty levels used were
20 and 40 per cent. With a level of 20 per cent the adjustment
in country 1, which has the larger capital stock, is spread over
periods 18 to 20 with the largest investment occurring in period 19.
In country 2 the full adjustment is still concentrated in period 19.
With the penalty of 40 per cent and the absolute constraint the
adjustment in country 1 is spread over periods 18 to 20 with the
maximum reached in period 20. In country 2 there is over investment
in period 19 and very small investment in period 20. This reflects
the decreasing returns to scale, investment may be concentrated
where scale is smaller as the output resulting from the investment

GRAPH 9.13   Adjustment Paths with Investment Constraints
               Decreasing Returns to Scale in Production

a.   Investment in Country 1

b.   Investment in Country 2

Notes:
1. The adjustment is due to an increase in the size of the markets
    in both countries.
2. The change is not anticipated by the MNC.

may be greater there, but this will partly depend on the scale factor of the production function.

A penalty of 10 per cent was also tried and gave the same results as the penalty of 20 per cent, while a penalty of 30 per cent gave the same results as the penalty of 40 per cent.

The effects of the investment constraints with increasing returns to scale in production and an anticipated parameter change were also considered. In this case the production functions are identical at $1.0K^{.35} L^{.80}$ and the market sizes are constant being 2400 in country 1 and 2000 in country 2. In this case a change in tax rates is used to achieve a complete switch of production from country 1 to country 2. For periods one to nine the tax rates are 50 per cent in country 1 and 40 in country 2, and are reversed for periods 10 to 39. The tariffs on imports equal zero for both countries for all time periods. Given the implicit assumption about which country is the home country this change implies a reversal of the home country. It is used instead of a combination of tax and tariff changes in order to illustrate certain points concerning a complete switch of production from one country to the other. The parameter change was put in period 10 to allow for more periods after the change.
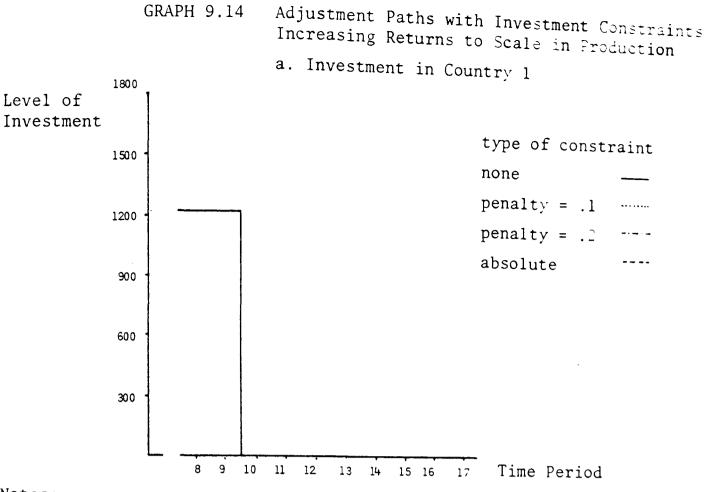
In this situation production is concentrated in the high tax rate country. Investment in country 1 continues up to and including period 9 so the capital stock is maintained until period 10, and this holds independently of any investment constraint. Investment in country 2 does not start until period 12

291

and there is no investment in either country in periods 10 and 11. With the depreciation rate of 20 per cent that is used the capital stock in country 1 takes until period 39 to fall to 9, and labour usage and the quantity produced have fallen to 1 at this point. Even with this slow decline the investment constraint still has some effect. With no constraint and a penalty of 10 per cent investment in country 2 reaches its maximum in period 13, but with a penalty of 20 per cent or an absolute constraint the maximum is reached in period 14. In cases investment reaches a stable level in period 25. The capital stock in country also increases steadily until period 25. The investment paths are illustrated in Graphs 9.14 a and b.
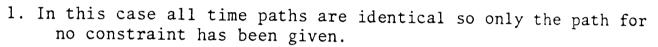
With higher depreciation rates the time required for the capital stock to decline to zero is reduced but the equilibrium level of capital·stock is reduced as the cost of replacing depreciation is also increased. Such results were run but are not reported in detail.
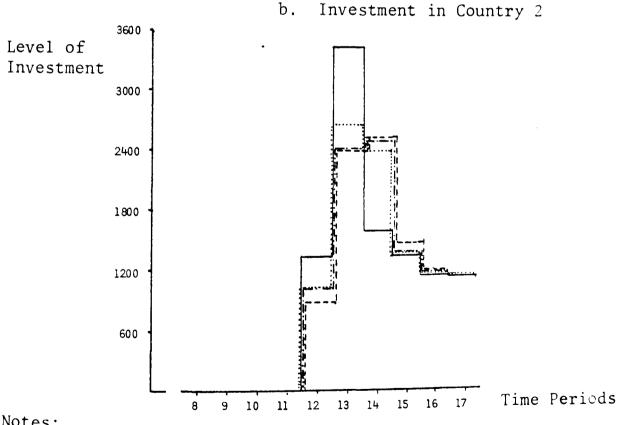
Alternative structures for the depreciation could change the result. Forms where capital goods have a fixed life would limit the adjustment period to the life of the capital good.

If the sale of the MNC's existing capital stock were allowed, either at the existing market price or at a reduced price, these results would be modified. By selling off some or all of its capital stock the MNC could reduce the adjustment period. The reasonableness of either alternative depends on the industry one is concerned with. It also depends on the importance of

GRAPH 9.14   Adjustment Paths with Investment Constraints
Increasing Returns to Scale in Production

a. Investment in Country 1

Level of
Investment

type of constraint

none ___

penalty = .1 ....

penalty = .2 --- -

absolute ----

Time Period

Notes:
1. In this case all time paths are identical so only the path for no constraint has been given.

b.   Investment in Country 2

Level of
Investment

Time Periods

Notes:
1. The adjustment is due to a change in profit tax rates.
2. The change is not anticipated by the MNC.

293

MNC's in the industry.   If many firms try to sell their capital

at the same time it will depress the prices for used capital goods

of that industry.

The direct shipment of capital goods from one country

to another has also been excluded.   There would be some, possibly

prohibitive, costs to this depending upon the industry involved,

and governments may take steps to prevent such a direct loss of

capital and jobs.   To consider these questions in more detail

involves extending the model, which is considered further in the

next section.

The penalty values used ranged from 10 to 40 per

cent, which may be somewhat high to be interpreted as costs of

borrowing.   With prices in the model being constant, the

penalties would have to be interpreted as real rates of interest.

The penalty of 10 per cent always had some effect, however, and

the possibility of such an interpretation could be explained further,

in part by looking at the effects of lower penalty values.

Alternative penalty functions, based on the absolute level of

investment, could be devised to reflect the costs of rapidly

adjusting the size of the firm, but these were not considered here.

This section has considered the two main types of

adjustments: those involving increases or decreases in the

capital stock of the MNC.   Additional combinations could be

considered, such as decrease in both countries, but the additional

results obtained would be limited.

9.4 POSSIBLE EXTENSIONS TO THE MODEL

This chapter has presented some results from the
dynamic programming model of the MNC.   These are illustrative of
what the model can do, but do not represent its full potential.
A number of extensions to the model are possible.   One is to make
some of the parameters of the model dynamic, such as having the
demand in one or both countries increase over time.   Another
is to use the model to consider specific questions and to combine
it with empirical work.

Making a parameter dynamic could be used to consider
a number of questions.   For example, increasing demand in the host
country could be used when considering the minimum size to which a
market must grow before the MNC will start local production.   The
effects of tariff increases, investment grants, and accelerated
depreciation allowances on this could be considered by varying the
values assigned to these over a number of runs of the model.   By
having the rate of growth of demand as a parameter of the model the
effect of this rate on the investment decision could also be explored.

Making a parameter dynamic would require some changes
to the computer program used here.   In particular, the two stage
calculation used here would no longer be appropriate.   With a
different parameter value being used for each time period all of
the calculation would have to be done for each period and a single
calculation over all six dimensions of the grid search would be
more efficient than the two stage process used here.   Another

change would be the need to specify the value of the parameter for each time period. One way to do this would be to specify either the initial or final period value and a rate of growth, which could be negative, and allow the program to calculate the remaining values.

Empirical studies could be used to find functional forms and parameter values that would be appropriate to the model. This would be particularly appropriate where the model is used to consider specific policy questions. The policy question would provide a context for the empirical work, defining the home country, the industry or set of industries to be considered, and the major host countries.

In using the model for this purpose a number of modifications can be made to it. The functional forms used for the production, demand, and tax functions can be changed by changing the equations of the model, with the choice of functional forms depending on the results of empirical work. Major revisions to the model that could be made include extending it to include a third country or to include two levels of production. The latter results in a vertically integrated model. The modification required would depend on the particular question being considered. An example of a model developed to consider a specific policy proposal, discussed in more detail in Chapter Five, is Horst (1971) which was concerned with changes in the tax credit allowed in the United States for taxes paid abroad.

This chapter has presented a type of model that can be used to consider a number of questions concerning MNC's, and illustrated the type of results that can be obtained from it. The computer time required to run the model increases as the complexity of the model is increased and thus it is appropriate to tailor the model to the specific questions being considered, instead of developing a very general model. Some ways in which this could be done have been suggested here.

Chapter Ten

CONCLUSION

Chapter Ten

CONCLUSION

This thesis has extended the theoretical work

on the MNC in two directions.   Theoretical explanations of the

reasons for and processes of FDI have been extended by the use

of the managerial theories of the firm and the mathematical

models of the profit maximizing MNC have been extended from

static to dynamic models.   To start, Chapter Two provides a

context for this.   Definitions of the MNC and of FDI are

provided and the possible range of objectives for the MNC are

considered.

The reasons for FDI were discussed in Chapter Three

by considering what set of conditions would be necessary and

sufficient for FDI to occur.   The effect of allowing different

firms to have different objectives upon the set of conditions was

also considered.   The conditions are:

1.   The firm possesses net ownership advantages vis a vis
      firms of other nationalities in serving particular
      markets where these ownership advantages largely
      take the form of the possession of intangible assets
      and are, at least for a time, exclusive or specific
      to the firm possessing them.

2.   It must be more beneficial to the firm possessing these
      advantages to use them itself rather than to sell or
      to lease them to foreign firms.

3. It must be profitable for the firm to utilize these advantages in conjunction with at least some factor inputs outside its home country, otherwise all production would take place in the home country and foreign markets would be served entirely by exports.

When firms can have alternative objectives those emphasizing the growth of the firm are more favourable to FDI than are those emphasizing profit maximization. Objectives of the former type can be treated as an advantage under condition 1, or can be considered as a separate item in the explanation of FDI. As a separate item they weaken the need for the first condition and have a role to play in explaining which firms may be leaders or followers in FDI in a given situation.

The attitude of the firm or its management to FDI was also considered. A positive attitude will lead to FDI by the firm under weaker conditions than are required if the firm has a negative attitude. This may be another part in the explanation of which firms are leaders or followers in under-taking FDI activities.

In Chapter Four the managerial theories of the firm approach was used to look at the process by which firms expand or diversify and this was related to the FDI decision. The skills a firm uses to serve one market can provide a basis for expansion to other related markets. The process by which the firm considers these opportunities gives rise to a pattern, with expansion to related home country markets being first and to related foreign markets being second. The relation between a firm's existing markets and other markets is based on some aspect of the firm such

as product type, production technology, or marketing skills.
The closer the relation the more information the firm will have
about the opportunities in the market. This gives rise to the
precedence of market opportunities in the home country. As the
pattern of skills used to serve a given market can differ between
firms, firms starting from the same industry can have different
patterns of expansion. Cross investments between developed
countries can be explained. Firms in both countries will have
skills that can be used in the markets of the other country.
Other empirical observations on MNC's can also be explained.
MNC's tend to be among the larger firms in any industry because
of the use of domestic expansion before foreign expansion. The
costs of investigating opportunities gives a preference for large
opportunities thus explaining why subsidiaries may be among the
larger firms in the host country.

Chapter Five presents a consolidation of the static
models of the profit maximizing MNC. The consolidated model is
of a two country MNC that produces a final good in both countries
and an intermediate good in one country. The model is general
enough to include, as special cases, many of those in the existing
literature. It goes beyond them in having the MNC export both a
final and an intermediate good from one country. The model
developed is used to show a number of limitations on the inter-
pretations of the results of the static models. The models in the
literature represent special cases and can produce conflicting
comparative static results. These results are concerned with

items such as the change in the level of trade that occurs in response to a change in the levels of profit taxes or tariffs. The difference in the results may be due to differences in the assumptions concerning relative profit tax rates in the home and host countries. Also, allowing for two types of trade from one country may lead to indeterminant results. One conclusion was that, as a real policy situation may involve the responses of a number of MNC's, where these may be represented by different special cases, the total response to a policy change will depend on an aggregation of a number of changes where some of these may offset one another.

The thesis then turned its attention to dynamic models of a profit maximizing MNC, with the structure of the model being specified in Chapter Six. Two mathematical techniques were used to develop the dynamic model, optimal control theory and dynamic programming. The optimal control theory version was presented in Chapter Seven. The structure of the dynamic program was presented in Chapter Eight and the results obtained from it were discussed in Chapter Nine.

The optimal control theory version of the model achieved very limited results. First-order conditions that hold at any point in time were obtained, but a condition for the levels of investment by the MNC could not be obtained and comparative dynamic results were not obtained. This was due to the lack of a solution for the set of simultaneous equations that resulted from the model. The use of restrictive functional forms, including an

assumption of a fixed capital to labour ratio, would have allowed for a solution. As a less restricted set of specific functional forms can be used with the dynamic program this approach was not pursued using the optimal control theory model. The lack of a solution for the model using general functional forms appeared to be due to the inclusion of the term for the level of trade in the demand equations. Without trade, however, the MNC becomes the simple sum of two one-country firms.

The dynamic programming version of the model both illustrated the technique and provided certain specific results. One set of results concerned the effects of varying the levels of tariffs and transfer prices on the level of trade by the MNC between the two countries of the model for each of decreasing, constant, and increasing returns to scale in production. The effect was found to depend on the relative rates of profit tax in the two countries. With equal taxes and a positive tariff, increasing the transfer price reduced the level of trade. With unequal taxes, changes in the transfer price can change the direction of trade. With the use of trade there is a shift of income due to the transfer price and there is a shift of costs due to the change of location of production. With a low transfer price the change in production and trade would shift more costs than it would income, so production would be located in the high tax rate country, and with a high transfer price the reverse situation would hold.

In the model, increasing the tariff was found to reduce the level of trade by the MNC. Usually there was an increase in production in the importing country but this was obtained at the expense of higher prices and reduced sales to local customers. Under increasing returns to scale in production, however, if the local market is small and is served entirely by imports, increasing the tariff could result in the MNC withdrawing from the market by stopping trade to it without starting local production.

A second set of results of the model looked at the time (in terms of numbers of the discrete periods used by the model) required for the MNC to adjust its stock of capital in each country in response to a change in the value of some parameter, usually of the demand function or the tax rates. This was considered both with no constraint and with a financial constraint on the level of investment. When the change required the capital stock to be increased, with no constraint the entire adjustment takes place in one period (assumed to be a year), and with a constraint the adjustment will be spread over three and sometimes four periods. Decreases in the capital stock, however, depended on the rate of depreciation. Where a partial reduction in the capital stock was required it could be achieved in two to four periods. A reduction of the capital stock to zero could, given the form of depreciation used in the model, take 20 or more periods, although most of the reduction would occur in the first few periods.

A number of ways in which the dynamic programming
model could be extended were also considered in section 9.4.
The main one was to use the model to consider specific questions,
with the functional forms and parameter values required by the
model being estimated empirically. The policy question being
considered would provide a contest both for the empirical work
and for choosing the structure of the model.

The extensions to the theory of the MNC presented
in this thesis have looked at two main questions. The first was
the conditions under which and reasons why an MNC would engage
in FDI. This could be used to consider policies by which host
countries or home countries could encourage or discourage specific
types of FDI. The reasons for such actions would depend on the
overall policy objectives of the host or home country. The
second looked at the response of the MNC to changes in its external
environment. Where these changes are policy changes by govern-
ments it allows the time lag before the response to the policy
occurs to be considered. The dynamic programming model can be
extended or modified to suit a specific policy question to be
considered, thus having a wide potential range of application.

B I B L I O G R A P H Y

BIBLIOGRAPHY

Adler, M. (1974).   The Cost of Capital and Valuation of a
    Two-Country Firm, Journal of Finance, vol,29, pp.119-132.

Adler, M. and Dumas, B. (1975).   Optimal International
    Acquisitions, Journal of Finance, vol.30, pp.1-19.

Adler, M. and Stevens, G.V. (1974).   The Trade Effects of Direct
    Investment, Journal of Finance, vol.29, pp.655-676.

Aharoni, Y. (1966).   The Foreign Investment Decision Process.
    Boston: Division of Research, Graduate School of
    Business Administration, Harvard University.

Aharoni, Y. (1971).   On the Definition of the Multinational
    Corporation, Quarterly Review of Economics and Business,
    vol.11, pp.27-37.

Aivazian, V.A. and Callen, J.L. (1979).   Investment, Market
    Structure, and the Cost of Capital, Journal of Finance,
    vol.34, pp.85-92.

Atkinson, A.B. (1969).   The Time Scale in Economic Models:
    How Long is the Long Run?, Review of Economic Studies,
    vol.36, pp.137-152.

Batra, R.N. and Hadar, J. (1979).   Theory of the Multinational
    Firm: Fixed Versus Floating Exchange Rates, Oxford
    Economic Papers, New Series, vol.31, pp.258-269.

Batra, R.N. and Ramachandran, R. (1980).   Multinational Firms
    and the Theory of Trade and Investment, American Economic
    Review, vol.70, pp.278-290.

Beedles, W.L. (1977).   A Micro-Economic Investigation of
    Multi-Objective Firms, Journal of Finance, vol.32,
    pp.1217-1233.

Benavie, A. (1972).   Mathematical Techniques for Economic Analysis,
    Englewood Cliffs: Prentice-Hall Inc.

Bergsten, C.F., Horst, T. and Moran, T.H. (1978). American
    Multinationals and American Interests. Washington:
    The Brookings Institution.

Boddewyn, J.J. (1979). Foreign Divestment: Magnitude and
    Factors, Journal of International Business Studies,
    vol.10, pp.21-27.

Booth, E.J.R. and Jensen, O.W. (1977). Transfer Prices in the
    Global Corporation Under Internal and External
    Constraints, Canadian Journal of Economics, vol.10,
    pp.434-446.

Buckley, P.J. and Casson, M. (1977). The Future of the
    Multinational Enterprise. London: MacMillan.

Buckley, P.J. and Pearce, R.D. (1979). Overseas Production
    and Exporting by the Worlds Largest Enterprises: A Study
    in Sourcing Policy, Journal of International Business
    Studies, vol.10, pp.9-20.

Casson, M. (1979). Alternatives to the Multinational Enterprise.
    London: MacMillan.

Caves, R.E.(1971). International Corporations: The Industrial
    Economics of Foreign Investment, Economica, N.S.,
    vol.38, pp.1-27.

Caves, R.E. (1974a). Causes of Direct Foreign Investment:
    Foreign Firms Shares in Canadian and United Kingdom
    Manufacturing Industries, Review of Economics and Statistics,
    vol.56, pp.279-293.

Caves, R.E. (1974b). Multinational Firms, Competition, and
    Productivity in Host Country Markets, Economica, N.S.,
    vol.41, pp.176-193.

Caves, R.E. (1975). Diversification, Foreign Investment, and
    Scale in North American Manufacturing Industries. Ottawa:
    Economic Council of Canada.

Caves, R.E. (1980). Industrial Organization, Corporate Strategy
    and Structure, Journal of Economic Literature, vol.18,
    pp.64-92.

Caves, R.E. and Porter, M.E. (1977). From Entry Barriers to
    Mobility Barriers: Conjuctural Decisions and Contrived
    Deterence to New Competition, Quarterly Journal of
    Economics, vol.91, pp.241-261.

Chiang, A.C. (1974). Fundamental Methods of Mathematical Economics, second edition. New York: McGraw-Hill.

Coase, R.H. (1937). The Nature of the Firm, Economica, N.S., vol.4, pp.386-405.

Copithorne, L.W. (1971). International Corporate Transfer Prices and Government Policy, Canadian Journal of Economics, vol.4, pp.324-341.

Day, R.H. and Groves, T. eds. (1975). Adaptive Economic Models. New York: Academic Press.

Douglas, P.H. (1948). Are There Laws of Production, American Economic Review, vol.38, pp.1-41.

Dreyfus, S.E. (1965). Dynamic Programing and the Calculus of Variations. New York: Academic Press.

Dunning, J.H. (1973). The Determinants of International Production, Oxford Economic Papers, New Series, vol.25, pp.289-336.

Dunning, J.H. (1974). Economic Analysis and the Multinational Enterprise. London: George Allen & Unwin.

Dunning, J.H. (1977). Trade, Location of Economic Activity and the MNE: A Search for an Ecletic Approach, in Ohlin, B., Hesselborn, P., and Wijkman, P.M. eds. The International Allocation of Economic Activity. London: MacMillan.

Dunning, J.H. (1979). Explaining Changing Patterns of International Production: In Defence of the Ecletic Theory, Oxford Bulletin of Economics and Statistics, vol.41, pp.269-295.

Eden, A.B.E. (1978). Vertically Integrated Multinationals: a Microeconomic Analysis, Canadian Journal of Economics, vol.11, pp.534-546.

Findlay, R. (1978). Relative Backwardness, Direct Foreign Investment, and the Transfer of Technology: A Simple Dynamic Model, Quarterly Journal of Economics, vol.92, pp.1-16.

Forsyth, D.J.C. (1972). U.S. Investment in Scotland, New York: Praeger.

Fowler, D.J. (1978). Transfer Prices and Profit Maximization in Multinational Enterprise Operations, Journal of International Business Studies, vol.9, pp.9-26.

Franko, L.G. (1976). <u>The European Multinationals, A Renewed Challenge to American and British Big Business.</u> London: Harper and Row.

Franko, L.G. (1978). Foreign Direct Investment in Less Developed Countries: Impact on Home Countries, <u>Journal of International Business Studies</u>, vol.9, pp.55-65.

Gaskins, D.W. (1971). Dynamic Limit Pricing: Optimal Pricing under Threat of Entry, <u>Journal of Economic Theory</u>, vol.3, pp.306-322.

Globerman, S. (1979). <u>U.S. Ownership of Firms in Canada: Issues and Policy Approaches.</u> Montreal: C.D. Howe Research Institute.

Gorecki, P.K. (1980). The Determinants of Foreign and Domestic Enterprise Diversification in Canada: A Note, <u>Canadian Journal of Economics</u>, vol.13, pp.329-339.

Hadley, G. and Kemp, M.C. (1971). <u>Variational Methods in Economics.</u> Amsterdam: North-Holland.

Helleiner, G.K. and Lavergne, R. (1979). Intra-Firm Trade and Industrial Exports to the United States, <u>Oxford Bulletin of Economics and Statistics</u>, vol.41, pp.297-311.

Hey, J.D. (1974). <u>Uncertainty in Microeconomics.</u> Oxford: Martin Robertson.

Hirsch, S. (1976). An International Trade and Investment Theory of the Firm, <u>Oxford Economic Papers, New Series</u>, vol.28, pp.258-270.

Hood, N. and Young, S. (1979). <u>The Economics of Multi-National Enterprise.</u> London: Longman Group Limited.

Horst, T. (1971). The Theory of the Multinational Firm: Optimal Behaviour under Different Tariff and Tax Rates, <u>Journal of Political Economy</u>, vol.79, pp.1059-1072.

Horst, T. (1972a). The Industrial Composition of U.S. Exports and Subsidiary Sales to the Canadian Market, <u>American Economic Review</u>, vol.62, pp.37-45.

Horst, T. (1972b). Firm and Industry Determinants of the Decision to Invest Abroad: An Empirical Study, <u>The Review of Economics and Statistics</u>, vol.54, pp.258-265.

Horst, T. (1973). The Simple Analytics of Multinational Firm Behaviour, in Connolly, M.B. and Swoboda, A.K. eds. International Trade and Money. London: George Allen and Unwin. pp.72-84.

Horst, T. (1974a). The Theory of the Firm, in Dunning, J.H. Economic Analysis and the Multinational Enterprise. London: George Allen and Unwin. pp.31-46.

Horst, T. (1974b). At Home Abroad: A Study of the Domestic and Foreign Operations of the American Food Processing Industry. Cambridge, Massachussets: Ballinger Publishing Company.

Horst, T. (1975). The Industrial Composition of U.S. Exports and Subsidiary Sales to the Canadian Market: Reply, American Economic Review, vol.65, p.235.

Horst, T. (1977). American Taxation of Multinational Firms, American Economic Review, vol.67, pp.376-389.

Hufbauer, G.C. (1975). The Multinational corporation and Direct Investment, in Kenen, P.B. International Trade and Finance: Frontiers for Research. Cambridge: Cambridge University Press.

Hymer, S.H. (1972). The Efficiency (Contradicitions) of Multinational Corporations, in Paquet, G. ed. The Multinational Firm and the Nation State. Toronto: Collier-Macmillan Canada.

Itagaki, T. (1977). Theory of Multinational Firms Under Fixed and Flexible Exchange Rates. Unpublished Ph.D. dissertation Southern Methodist University.

Itagaki, T. (1979). Theory of the Multinational Firm: An Analysis of the Effects of Government Policies, International Economic Review, vol.20, pp.437-448.

Itagaki, T. (1980). Vertically Integrated Multinationals, Canadian Journal of Economics, vol.13, pp.176-177.

Jenkins, G.P. (1979). Taxes and Tariffs and the Evaluation of the Benefit from Foreign Investment, Canadian Journal of Economics, vol.12, pp.410-425.

Johanson, J. and Vahlne, J. (1977). The Internationalization Process of the Firm - A Model of Knowledge Development and Increasing Foreign Market Commitments, Journal of International Business Studies, vol.8, pp.23-32.

311

Katrak, H. (1977). Multi-National Monopolies and Commercial Policy, <u>Oxford Economic Papers, New Series</u>, vol.29, pp.283-291.

Kindleberger, C.P. (1970). <u>The International Corporation</u>. Cambridge: The M.I.T. Press.

Kirman, A.P. (1975). Learning by Firms About Demand Conditions, in Day, R.H. and Groves, T. eds. <u>Adaptive Economic Models</u>. New York: Academic Press.

Klein, B., Crawford, R.G. and Alchian, A.A. (1978). Vertical Integration, Appropriable Rents, and the Competitive Contracting Process, <u>The Journal of Law and Economics</u>, vol.21, pp.297-326.

Knickerbocker, F.T. (1973). <u>Oligopolistic Reaction and Multinational Enterprise</u>. Boston: Harvard University.

Kohlhagen, S.W. (1977). Exchange Rate Changes, Profitability, and Direct Foreign Investment, <u>Southern Economic Journal</u>, vol.44, pp.43-52.

Kopits, G.F. (1972). Dividend Remittence Behaviour Within the International Firm: A Cross Country Analysis, <u>Review of Economics and Statistics</u>, vol.54, pp.339-342.

Kopits, G.F. (1976a). Taxation and Multinational Firm Behaviour: A Critical Survey, <u>International Monetary Fund Staff Papers</u>, vol.23, pp.624-673.

Kopits, G.F. (1976b). Intra-Firm Royalties Crossing Frontiers and Transfer Pricing Behaviour, <u>The Economic Journal</u>, vol.86, pp.791-805.

Kopits, G.F. (1979). Multinational Conglomerate Diversification, <u>Economica Internazionale</u>, vol.32, pp.99-111.

Krainer, R.E. (1972). The Valuation and Financing of the Multi-National Firm, <u>Kyklos</u>, vol.25, pp.553-574.

Kwack, S.Y. (1972). A Model of Direct Investment Abroad: A Neoclassical Approach, <u>Western Economic Journal</u>, vol.10, pp.376-383.

Ladenson, M.L. (1972). A Dynamic Balance Sheet Approach to American Direct Foreign Investment, <u>International Economic Review</u>, vol.13, pp.531-543.

Lall, S. (1973). Transfer Pricing by Multinational Manufacturing Firms, Oxford Bulletin of Economics and Statistics, vol.35, pp.173-195.

Lall, S. (1975). Foreign Private Manufacturing Investment and Multinational Corporations: An Annotated Bibliography. New York: Praeger Publishers.

Lall, S. (1979). The International Allocation of Research Activity by U.S. Multinationals, Oxford Bulletin of Economics and Statistics, vol.41, pp.313-331.

Lall, S. (1980). Monopolistic Advantages and Foreign Involvement by U.S. Manufacturing Industry, Oxford Economic Papers, New Series, vol.32, pp.102-122.

Lee. W.Y. and Schadeva, K.S. (1977). The Role of the Multinational Firm in the Integration of Segmented Capital Markets, Journal of Finance, vol.32, pp.479-492.

Leibenstein, H. (1976). Beyond Economic Man. Cambridge, Massachusetts: Harvard University Press.

Leibenstein, H. (1979). A Branch of Economics is Missing: Micro-Micro Theory, Journal of Economic Literature, vol.17, pp.477-502.

Leland, H.E. (1972). The Dynamics of a Revenue Maximizing Firm, International Economic Review, vol.13, pp.376-385.

Litvak, I.A., Maule, C.J. and Robinson, R.D. (1971). Dual Loyalty: Canadian-U.S. Business Arrangements. Toronto: McGraw-Hill.

Lloyd, C., Rapport, D. and Turner, J.E. (1975). The Market Adaptation of the Firm, in Day, R.H. and Groves, T., eds. Adaptive Economic Models. New York: Academic Press, pp.119-135.

Magee, S.P. (1977a). Information and the Multinational Corporation: An Appropriability Theory of Direct Foreign Investment, in Bhagwati, J.N. ed. The New International Economic Order: The North South Debate. Cambridge: The M.I.T. Press.

Magee, S.P. (1977b). Multinational Corporations, the Industrial Technology Cycle, and Development, Journal of World Trade Law, vol.11, pp.279-321.

Magee, S.P. (1977c). Application of Dynamic Limit Pricing Model to the Price of Technology and International Technology Transfer, Journal of Monetary Economics, Supplementary Series, vol.7, pp.203-224.

Marris, R. and Mueller, D.C. (1980). The Corporation, Competition, and the Invisible Hand, Journal of Economic Literature, vol.18, pp.32-63.

McEachern, W.A. (1978). Corporate Control and Growth: An Alternative Approach, Journal of Industrial Economics, vol.26, pp.257-266.

McManus, J. (1972). The Theory of the International Firm, in Paquet, G. ed. The Multinational Firm and the Nation State. Toronto: Collier-Macmillan Canada.

Miller, J.C. and Pras, B. (1980). The Effect of Multinational and Export Diversification on the Profit Stability of U.S. Corporations, Southern Economic Journal, vol.46, pp.792-805.

Mossin, J. (1973). Theory of Financial Markets. Englewood Cliffs: Prentice-Hall.

Muzondo, T.R. (1979). The Corporation Income Tax and Depreciation Policy in the Short Run, Canadian Journal of Economics, vol.12, pp.15-28.

Naumann-Etienne, R. (1974). A Framework for Financial Decisions in Multinational Corporations - Summary of Recent Research, Journal of Finance and Quantative Analysis, vol.9, pp.859-874.

Nelson, R.R. (1980). Production Sets, Technological Knowledge, and R and D: Fragile and Overworked Constructs for Analysis of Productivity Growth? American Economic Review, vol.70, pp.62-67.

Nickell, S.P. (1978). The Investment Decisions of Firms. Cambridge: Cambridge University Press.

Orr, D. (1975). The Industrial Composition of U.S. Exports and Subsidiary Sales to the Canadian Market: Comment, American Economic Review, vol.65, pp.230-234.

Ozawa, T. (1979). International Investment and Industrial Structure: New Theoretical Implications from the Japanese Experience, Oxford Economic Papers, New Series, vol.31, pp.72-92.

Paquet, G. ed. (1972). The Multinational Firm and the Nation State. Toronto: Collier-Macmillan Canada.

Parker, J.E.S. (1974). The Economics of Innovation, The National and Multinational Enterprise in Technological Change. London: Longman Group Limited.

Parry, T.G. (1973). Some Aspects of Asset Creation by the International Firm, Journal of Business Policy, vol.3, pp.37-47.

Ragazzi, G. (1973). Theories of the Determinants of Direct Foreign Investment, International Monetary Fund Staff Papers, vol.20, pp.471-498.

Richardson, J.D. (1971). Theoretical Considerations in the Analysis of Foreign Direct Investment, Western Economic Journal, vol.9, pp.87-98.

Robbins, S.M. and Stobaugh, R.B. (1974). Money in the Multinational Enterprise: A Study of Financial Policy. London: Longman Group.

Rodriguez, R.M. (1974). Management of Foreign Exchange Risk in the U.S. Multinationals, Journal of Finance and Quantative Analysis, vol.9, pp.849-857.

Ronstadt, R.C. (1978). International R and D: The Establishment and Evolution of Research and Development Abroad by Seven U.S. Multinationals, Journal of International Business Studies, vol.9, pp.7-24.

Rugman, A.M. (1979). International Diversification and the Multinational Enterprise. Lexington, Massachusetts: Lexington Books.

Sandler, T. and Cauley, J. (1980). A Hierarchical Theory of the Firm, Scottish Journal of Political Economy, vol.27, pp.17-29.

Scherer, F.M. et.al. (1975). The Economics of Multi-Plant Operations: An International Comparisons Study. Cambridge, Massachusetts: Harvard University Press.

Severn, A.K. and Laurence, M.M. (1974). Direct Investment, Research Intensity, and Profitability, Journal of Finance and Quantative Analysis, vol.9, pp.181-190.

Sibley, D.S. (1977). The Demand for Labor in a Dynamic Model of the Firm, Journal of Economic Theory, vol.15, pp.252-265.

Simon, H.A. (1979). Rational Decision Making in Business Organizations, _American Economic Review_, vol.69, pp.493-513.

Smith, V.K. and Cowing, T.G. (1977). Further Analysis of Optimal Repair, Scrappage and Investment Policy, _Scandinavian Journal of Economics_, vol.79, pp.354-360.

Soderstrom, H.T. (1977). Team Production and the Dynamics of the Firm, _Scandinavian Journal of Economics_, vol.79, pp.271-288.

Solomon, R.F. and Ingham, K.P.D. (1977). Discriminating Between MNC Subsidiaries and Indigeneous Companies: A Comparative Analysis of the British Mechanical Engineering Industry, _Oxford Bulletin of Economics and Statistics_, vol.39, pp.127-138.

Spitaller, E. (1971). A Survey of Recent Quantative Studies of Long Term Capital Movements, _International Monetary Fund Staff Papers_, vol.18, pp.189-220.

Stevens, G.V.G. (1969). Fixed Investment Expenditures of Foreign Manufacturing Affiliates of U.S. Firms: Theoritical Models and Empirical Evidence, _Yale Economic Essays_, vol.9, pp.137-198.

Stevens, G.V.G. (1974). The Determinants of Investment, in Dunning, J.H. _Economic Analysis and the Multinational Enterprise_. London: George Allen and Unwin. pp.47-88.

Stewart, J.C. (1977). Multinational Companies and Transfer Pricing, _Journal of Business Finance and Accounting_, vol.4, pp.353-371.

Stobaugh, R.B. (1977). Competition Encountered by U.S. Companies that Manufacture Abroad, _Journal of International Business Studies_, vol.8, pp.33-43.

Svedberg, P. (1979). Optimal Tariff Policy on Imports from Multinationals, _The Economic Record_, vol.55, pp.64-67.

Sylos-Labini, P. (1969). _Oligopoly and Technical Progress_. Cambridge, Massachusetts: Harvard University Press.

United States Department of Commerce. (1980). _Survey of Current Business_, vol.60, no.8.

Vernon, R. (1966). International Investment and International Trade in the Product Cycle, _Quarterly Journal of Economics_, vol.80, pp.190-207.

316

Vernon, R. (1971).   Sovereignty at Bay: The Multinational
     Spread of U.S. Enterprise.   London: Longman Group
     Limited.

Vernon, R. (1979).   The Product Cycle Hypothesis in a New
     International Environment, Oxford Bulletin of Economics
     and Statistics, vol.41, pp.255-267.

Wildsmith, J.R. (1973).   Managerial Theories of the Firm.
     London: Martin Robertson and Company Limited.

Williamson, O.E. (1975).   Markets and Hierarchies: Analysis
     and Antitrust Implications.   New York: The Free Press.

Willig, R.D. (1979).   Multiproduct Technology and Market
     Structure, American Economic Review, vol.69, pp.364-351.

Wolf, B.M. (1975).   Size and Profitability Among U.S.
     Manufacturing Firms: Multinational Versus Primarily
     Domestic Firms, Journal of Economics and Business,
     vol.28, pp.15-22.

Wolf, B.M. (1977).   Industrial Diversification and
     Internationalization: Some Empirical Evidence, Journal
     of Industrial Economics, vol.26, pp.177-191.