ON PREDICTION
OF THE SIZE AND SHAPE
OF PORT HINTERLANDS

TOWARDS A MODEL
TO PREDICT THE SIZE AND SHAPE
OF PORT HINTERLANDS

by

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SCOPE AND CONTENTS:

This thesis argues that a theoretical approach to the study of the size and shape of port hinterlands is required if we are to know what factors affect this phenomenon. Following a review of the literature dealing with port hinterlands, a model is devised to predict the location of port hinterlands. This model uses data neither of actual commodity movements nor of port clearances as variables to explain the size and shape of port hinterlands, and uses instead only those factors that are constant or predictable. The reason for this decision is that the commodity data can give us only the hinterlands of the past whereas we are interested as much in the hinterlands of the present and the near future.

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CHAPTER I

INTRODUCTION

Port hinterlands are an important geographical factor contributing to the growth or decline, to the success or failure of all ports and in great part they dictate the kind of activities in which each port shall indulge. As a result the port hinterland has usually been studied as a fixed area of land and the nature of this land has been shown to have an important effect on the fortunes of its ports. However, the various port authorities are no longer interested in sitting back and being dictated to by circumstances. There is an increasing awareness that, with greater understanding of the nature of a hinterland, it becomes much easier to manipulate it to advantage, whether it be for private good by securing trade from rival ports, or for public good by stimulating new trade. Most port authorities realise that the boundaries of their hinterlands change periodically and some may well recognise that their actions occasionally precipitate such boundary movements, but few have attempted to enlarge scientifically their hinterlands and most, possibly, fail to realise the power that is at their elbow.

Therefore it is necessary for us to understand the nature of port hinterlands and the factors that control their size and their shape if we are to understand how and why they vary. Instead of studying port hinterlands as a mere appendage to a port study in an

attempt to explain the nature and size of that port, this thesis will be concentrating on the study of the port hinterland as a phenomenon in its own right. This is not an attempt to understand the size and shape of any one specific port hinterland but to understand the nature of all port hinterlands, irrespective of differing geographical locations or historical periods.

This thesis will thus attempt to isolate the various factors that help to determine the size and shape of port hinterlands so that the effects of port policies and of proposed changes can be predicted with as much accuracy as possible. It is to be hoped that, as a result, data on all the factors subsequently considered as relevant could be collected so that an actual network of port hinterlands could be drawn up. Actual movements of goods are not part of the data to be collected however for this in essence is the variable to be explained and predicted. The benefit of this is that one would then be able to delineate a system of port hinterlands for either the past, the present, or the near future, whereas reliance on actual trading figures would restrict one to commenting only on past distributions as a result of the time lag connected with publishing statistics. Port authorities may be interested in the shape of their hinterland two or three years previously but they are more likely to show interest in maps showing their present and their potential future hinterlands.

It should be made clear here that the network of hinterlands that would be so drawn up would be an attempt to measure and show the <u>actual</u> port hinterlands as they exist at that point in time. It is not an attempt to show the 'ideal' port hinterlands for that area

whereby the whole system of trading would be able to function most efficiently. Actual port hinterlands can of course be obtained by reference to actual trading patterns, but this thesis is attempting to predict it with the use of other factors. This may well then enable us to state what is the present pattern, what will be the pattern for the limited future, and what was the pattern in those years for which we have no data.

Although much time and effort has been expended upon the study of hinterlands, very little of this has been aimed at studying them as a separate phenomenon rather than as a part of a port study. Most of this work could be classed as empirical, consisting often of the study of actual port hinterlands, of their actual size, of their shape, and of their nature, and the conclusions drawn therefrom will have relevance for that hinterland studied, but will not necessarily help us to understand the nature of the hinterlands.

Instead, what is required is a basic theory applicable to ports and hinterlands irrespective of location, prevailing technology, and historical time. It is believed that the variables which affect the size and shape of all hinterlands have not varied in time, nor vary from area to area. It is hoped that, by understanding the factors taken into account by buyers and sellers in their choice of trade routes, this study will be able to isolate these variables and predict their effects. The need for such predictive powers was demonstrated clearly in Canada when, even in 1958, people were at a loss to forecast the effects upon ports and hinter-

lands of the impending opening of the St. Lawrence Seaway (1). The interrelationships of these universal variables will of course be complex and their effects will be difficult to predict, but some of the groundwork has already been completed.

The majority of works are focussed mainly on the ports themselves and although the existence of a hinterland will usually be mentioned as a contributary factor to the size and nature of its port's activities, rarely are its own size and shape studied. It is quite conceivable that the answers sought after will come eventually from this kind of empirical work but so far the results have been disappointing, and this study instead will attempt to solve the problems by a theoretical approach. Empirically derived theories are characterised by the dominance of preliminary observation and data-collection which are then used to formulate a theory which fit the observed facts at that place. It is difficult, however, to know whether this theory fits the facts in different places or at different times without continuous testing. If however a model was constructed on purely theoretical grounds and then tested randomly against various backgrounds and historical periods one would be able to tell much more quickly whether the model's predictive capacities were worthwhile, or whether they worked only in certain situations, or whether they were worthless, by comparing the resultant predicted system of hinterlands with the observable pattern. Normally such tests show that one or two variables had been overlooked or wrongly stressed and often points them out clearly. The idea then is that the model is 'repaired'

and brought nearer to perfection -- perfection being that state in which a model can always, given the relevant data, predict the actual pattern of events. Such a method, whereby theories are conceived before the confrontation with reality, gains support from Alfred Weber (2):

> "I believe, however, that it will be better to present this factual material where it belongs, both as a matter of logic and as a matter of practical presentation: after the pure theory and before the realistic theory. It is impossible to analyse or arrange this material at all without an abstract theory of location. I have indeed gained it myself from this analysis; only out of an abstract theory and a clear survey of the facts can the realistic theory be compounded."

Similar methods have been successfully used in other branches of economic geography, notably with the subject of market areas of industrial and retail concerns, by Greenhut and others (3). In most of these studies the market area of the plant or store is considered to be a constant and the location of that plant or store to be a variable. The major difference between those studies and this will be that, here, the location of the port (or industrial or retail concern) will be taken as given, and it will be the shape and size of the hinterland (or market area) that will be allowed to vary. Although this introduction does not intend to press the claims of theoretical as against empirical research, it should be pointed out that so far the latter approach has not yet provided a proper understanding of the phenomenon of the hinterland, whereas theoretical enquiries into similar phenomena -- such as market areas -- have yielded worthwhile insights into their nature. In Greenhut's paper, for example, he studies the effect of variations in two factors, in influencing the size and shape of the market area of a firm. He realises that there are other influences, such as the effect

of the marginal revenue and cost curves upon the output of the firm, and therefore upon the maximum total market it could supply, but he believed the first two to be of major importance and kept his analysis just to these. In this way he has enabled us to understand and to perceive in reality the market areas of firms and why they have such a shape and size, (4). The difficulty of empirically defining market areas has meant that little could be learnt of their nature; but this a priori method, although it may not give us an exact representation of the truth, if logically sound, does help us to understand why the market area changes in shape and, to a certain extent, will allow us to draw their boundaries.

Greenhut's work is closely related to the present study in that a hinterland can be regarded as the market area for the services of a port and that, to a certain extent, a port is a competitor for trade in exactly the same way that a manufacturer is. The similarity of the two objectives and the success which attended Greenhut's efforts have only strengthened the conviction of the author that this kind of theoretical approach is the most suitable method for the purpose outlined.

The thesis begins with an examination and criticism of the contributions already made that have furthered our understanding of the problems associated with the study of port hinterlands, pointing out the possible directions that could be taken and many of the obstacles that will need to be surmounted or discounted. Chapter three is devoted to a definition of the terms involved and especially to an unequivocal definition of a port hinterland. The fourth chapter is an attempt to isolate the various factors involved in port hinterlands and to note their effects, amalgamating some, discarding others and finishing with

a simple equation by which, it is believed, shippers will make routeing decisions. From here the fifth chapter attempts to translate this into a predictive model. It shows the complexity of the problem of trying to predict any given set of port hinterlands from this model and suggests how this model can in fact be simplified. Finally, Chapter VI concludes by commenting on the findings of the research and by discussing the model's applications and limitations.

It had been intended at the beginning of this study to test this model. This would have involved the collection of all commodity movement data for a certain time-period and area and using it to draw up an actual network of hinterlands. This would then have been compared with the network of hinterlands predicted by the model on the basis of the actual values of the variables for that time period. However, Chapter V shows that there is still some necessary groundwork to be attempted before this procedure can be implemented. It is hoped that this thesis, by stressing the need for this groundwork, will instigate this research and thus lead to a more effective testing of the developed model.

Footnotes to Chapter I

(1) e.g. see P. Camu, "Le port de Montreal a la veille de l'ouverture de la nouvelle voie navigable du Saint-Laurent", Cahiers de Geographie de Quebec, V (1959), 85-96.

(2) A. Weber, The Theory of Location of Industries, trans. C. Friedlander (Chicago: University Press, 1929), p. 12.

(3) e.g. see M. L. Greenhut, "The size and shape of the market area of a firm", Southern Economic Journal, XIX (1952), 37-58; and H. Hotelling, "Stability in competition", Economic Journal, XXXIX (1929), 41-57.

(4) Greenhut, op. cit.

CHAPTER II

THE CONCEPT OF HINTERLAND IN GEOGRAPHIC LITERATURE

A. Introduction.

The purpose of this review of preceding works on hinterlands is twofold: firstly, it will enable us to see how others thought of hinterlands; and secondly, we can extract from the list of factors held responsible for the size and shape of this phenomenon those that appear to be most important. This will allow us to formulate a workable definition of a port hinterland and help us recognize those factors which would operate upon it as it is defined.

First of all we shall study some of the reasons given by the authors for their interest in port hinterlands and then shall look in detail at their definitions or concepts concerning this phenomenon. This will be followed by a study of the individual factors put forward, classified by nature rather than by author or time period.

Four main points will be seen to emerge from this review of literature -- firstly, that there is a lack of consistency in the use of the term hinterland, it being used to describe a wide variety of conditions; secondly, that a great multitude of factors has been considered as relevant to the size and shape of hinterlands, although few writers have considered more than a mere handful; thirdly, that these factors are very often listed as such, but are not accompanied by supporting statements of the logic behind their nomination or of the effect they would have; and finally, that there have been several admissions of failure by those who attempted to

define a hinterland and tried to see it as a measurable phenomenon. It is hoped that this study will enable us to see why these failures have occurred so that we may try and avoid a repetition by using the best definition available.

B. Purposes.

Within the realm of geographic literature there have been five main groups of writings that have concerned themselves with port hinterlands. Firstly, there are those who have centred their study on hinterlands as a phenomenon, studying it as an abstract idea or concept rather than as a series of case-studies. The three major exponents in this field have probably been Sargent, Morgan, and Bird (1). Their books have all concerned themselves with both ports and hinterlands but they each devote at least a chapter to a theoretical discussion of the nature of hinterlands -- Sargent as an introduction to his work, Morgan as an integral part of the book, and Bird as a termination or conclusion. The purpose of the writers is not usually made clear, but lies implicit in their work.

Sargent, however, does explicitly state his purpose in the preface and it was, essentially, an attempt to understand as much as possible about hinterlands. "The problem set is to determine and explain, as far as possible, the extent and character of these areas and their connexion with other areas beyond the seas," (2). Morgan's main concern appears to have been the writing of a long-overdue textbook on "Ports and Harbours" and appeared to use the concept of the hinterland as an aid to understanding the nature, size, and trade of each port -- therefore it was necessary to delve back one stage more and discern how in fact hinterlands work and form. Bird's purpose is however more clouded. He discusses

a theory of port development against which he measures the historical growth and present stature of Britain's major ports with barely a reference to hinterlands, but concludes by discussing the inter-relationships of port and hinterland in theory, although with a liberal use of British examples. The purpose of such a chapter is not made clear but it has indeed contributed to our understanding of the hinterland.

A second group of writings could be called single hinterland studies, in which geographers have pre-occupied themselves with the study of one port hinterland, irrespective of the hinterlands of competing ports. The outstanding example of this kind of work was produced by Marion Matheson on St. John, New Brunswick, but similar works have come from I. E. Muddle, J. Deprez, Pierre Camu, Guido Weigend, and Drs. R. C. Harkema (3). In Matheson's case the study seemed to be an end in itself, studying the origins and destinations of goods that travelled through the port by type of good, by direction, and by season. Muddle's purpose in studying Dover's hinterland was to see whether Dover was the best port for that area, while Deprez in a sense reconnoitred North-West Europe to see if Antwerp's hinterland could be expanded or at least maintained. Camu and Harkema had as their purpose the description of their respective hinterlands, as did Weigend with Bordeaux. In the second article, however, Weigend looks at his predecessor's use of the word hinterland and shows how none of them alone satisfies the facts as developed at Hamburg -- his purpose here is thus almost one of testing.

Many other students of the subject progressed beyond studying single hinterlands and attempted to measure the influences of competing ports and their hinterlands. This could be called the third group of

writings. As with the previous two groups, there is a great disparity of purposes, as well as of methods. Chambers, for example studied the various ports of Texas and how they had obtained their portions of the whole hinterland; Morgan used trade statistics to show the affiliations that various areas had with a port or ports; van Cleef was intrigued by the fact that hinterlands were not the shape he had expected and attempted to explain this; and Weigend later studied an inland area and the various forces that are at play in attracting or attempting to attract trade from that area through certain ports (4). A completely different approach and purpose was exhibited by Braine when, by taking into account two factors only, he attempted to delimit the potential competitive hinterland of Chicago, his purpose being the benefit of that port (5).

The fourth group of writings could be classified as port studies and, almost without exception, these have delved into the field of hinterlands and their nature only in as far as it can assist with the main purpose, the understanding of the size and nature of trade of a given port or ports. Nevertheless, despite this, many contributions have been made to the study of hinterlands and these will be looked at in more detail in the following sections.

Similarly the fifth group of writings, those whose main interest is the sea and shipping, have contributed to the study of hinterlands but this has been a by-product of the main purpose, usually an explanation of shipping lanes, or of the nature of cargoes.

The number of non-geographic writings on hinterlands has been comparatively few, probably as the result of the hinterland being solely a spatially-recognised feature. However, Crawford used the concept of

hinterlands, and enlarged upon it, in explaining archaeological finds; Albion and Harbeson studied it from the point of view of economic history and business politics in an attempt to explain the history of commercial seaports; the Turner Report studied the hinterland of Montreal to try and predict the effects of the opening of the St. Lawrence Seaway upon the fortunes of that port; and Spoehr studied it as an anthropological and cultural feature (6).

The study of hinterlands, not surprisingly, has benefited from this wide range of purposes and methods of study, giving it a broader base and a wealth of ideas and factual material that is usually missed when effort is all concentrated upon one purpose and one method. As a result, however, there has developed a large collection of phenomena termed hinterlands and an even larger collection of factors to account for them, and these are now studied in the hope that these numbers can be trimmed to provide us with one or two acceptable definitions of a hinterland and a minimum number of factors to account for it, to assist in data-collection and study.

C. Definitions.

The earliest definition that we have of hinterland is that of the Oxford English Dictionary which called it "the district behind that lying along the coast (or along the shore of a river); the 'back country'," (7). This definition was written in 1898, only eight years after its earliest recorded use as an English word (it coming directly from the German and meaning 'land behind'). Within the short span of seventy-five years, however, it has been assimilated into several disciplines, one of which being geography, and has acquired many subtle differences of meaning.

L. D. Stamp has made a collection of the various geographical

definitions and the earliest he found was that by H. R. Mill in 1910: a hinterland is "that region the seaborne trade of which belongs to a particular seaport or seaboard," (8). In general most geographers after Mill have tended to follow this definition only vaguely, with no one definition being adhered to by more than a few followers. Sargent, indeed, remarked in 1938 that "the label [hinterland] is so convenient that we cannot avoid its use; the real difficulty is to attach to the word a meaning sufficiently precise to be of some scientific value," (9). Sargent himself is one of the few who have tried to obtain such a scientific definition.

One point about Mill's definition on which all geographers appear to agree is that the words "or seaboard" should not be used. Though none has actually said it, all works referred to have used the word hinterland purely in connection with single ports, and never with reference to seaboards.

Of the several different approaches to the problem (of defining actual hinterlands) used by geographers, a noticeable point is that some see the problem purely in geographical terms and others see it in economic or statistical terms. Generally speaking, as time has progressed fewer people have been thinking of hinterlands as geographical entities and are now referring to them more often as economic or statistical phenomena. Back in 1922, for example, Crawford envisioned hinterlands as being geographical, spatially contiguous areas with ports being chosen as near to the hinterland as possible. In speaking of prehistoric times "the determining factor is a reduction to a minimum of the land journey", although he recognizes that "nowadays, roads and railways have so altered land

communication that a few miles makes no difference," (10). Straight-line distances were also considered to be the controlling factor by Denzil Ridout who considered that the future of Port Churchill was assured simply because it was the nearest port to the great granary of the Prairies (11).

Meanwhile, in Germany, Mecking was referring to hinterlands of ports as physical regions, split up by mountain ridges and dominated by river basins (12). He was discussing the harbours of Japan, where most of them are, indeed, centrally placed with respect to river basins, but this use of the word would be meaningless on the North European Plain where one hinterland would be served by the whole coastline. The possibility, however, is that he was using the word as defined in the O.E.D. (7) and talking merely of the inland parts of Japan. In yet another article published in 1931, Albion also spoke of the hinterlands of the North Atlantic ports as being the whole area west of the Appalachians -- thus to him also it was a geographical region, more akin to 'the back region' than to 'the region served by a port', (13).

It was Sargent who first thought in terms of a statistical outlook and definition of a hinterland. He admitted that it was "possible to imagine a perfect physical hinterland, bounded by an impassable physical barrier interposed by nature and confining the area served by a port within rigid geographical limits", (14), but confessed he was unable to find such a case. Then he suggested that, if physical barriers did not prove to be dominant, then perhaps all goods are shipped out through the nearest port giving, as he termed it, a 'geographical' hinterland rather than a physical one, (15). (This form of hinterland, based on straight-line distances, is henceforth referred to as a 'natural' hinterland). However,

again Sargent realised that such hinterlands rarely if ever occurred because of a multitude of factors that he then enumerates, and that one can only refer to a hinterland as an economic spatial unit attached to a port. As such, it need not follow any physiographic or 'natural' lines and that therefore "the conception of a hinterland, while closely related to and based on geography, must be largely statistical since statistics express the result of all the factors in combination," (16).

However, in the following year (1939) and again in 1947 Frank Walker was describing the hinterland of Bristol as the five south-western and south-west Midlands counties, and then continuing to state that much of this land exports through London and Liverpool in preference to Bristol for several reasons, (17). One wonders, therefore, why he thus delimited that port's hinterland unless it was simply that those areas were nearer to Bristol than to any other port of comparable size -- this again would be a 'natural' hinterland and totally unrelated to actual commodity flow.

In 1945, similar points were being made by Eugene van Cleef to those raised earlier by Sargent. He stated that "in the absence of political or other arbitrary limitations, the hinterland coincides with the area of the port's ready accessibility" and that "under ideal conditions the hinterland of a port would coincide exactly with the drainage basin of the river system at whose mouth the port was located," (18). As a result of many modifying factors, notably politics, goods would not travel the expected way and "thus a purely statistical delimitation of a port's hinterland based on its imports and their destinations and its exports and their points of origin may not be an absolute index to the normal or natural hinterland," (19). He thus recognised that statistical methods were

the only way of finding out about actual trade movements but contended that the spatial area so involved could not legitimately be termed the hinterland which to him still had a physical or at least 'natural' connotation.

Later works have done little to solve this problem. Matheson (2) studied hinterlands purely on a statistical basis; Brook (21) described the hinterlands of Borneo's ports as corresponding with relief divisions; and Spoehr still refers to the hinterland as the backward, uncultivated areas of natives (22). The balance does appear to lie with statistical analysis at the moment however, mainly as a result of the enquiries of Morgan, Weigend, and Shaffer, (23).

Assuming that a geographer has now decided to study either statistical or 'natural' hinterlands, he will still be faced with decisions. One of these is whether to treat the hinterland as competitive or non-competitive -- that is to say, whether the hinterland he wants to define is that area that ships more through that port than through any other; or is that whole area that ships goods through any given port. The answer will depend partly on the purpose the geographer has in mind. If it is merely to describe the trading pattern of any port or ports then the total or non-competitive hinterland may well be sufficient. However, if he wishes to indicate potential in any way, he will find that perhaps a competitive type of hinterland would be preferable.

The majority of works reviewed do in fact study hinterlands mainly on a non-competitive basis. There are two reasons for this however -- firstly, many of these works are primarily port studies with details of hinterlands as supplementary or explanatory data; secondly, it is much

simpler to construct one of the total hinterland maps than a competitive hinterland map because one needs to deal only with the statistics of one port. Normally the author will add comments such as that beyond a given area the port experiences competition from others but is rarely able to draw the boundary of this area. This leads to the phenomenon known as overlapping hinterlands where two or more ports are said to share in the competitive hinterland. The existence of these is not doubted but many authors have preferred to divide such areas up according to the port that handles most of the trade. The reason for this is that they consider that total hinterlands are worse than useless for they lead the reader to suppose that the port is far more important than it actually is. For example, Matheson includes Vancouver and even Victoria in the hinterland of Saint John because it handled some commodities for those places (24), although it should be obvious that these goods form a minute proportion of all goods exported from and imported into the Vancouver region.

An observed trend of recent years is the abandonment of attempts to measure actual competitive hinterlands for attempts to predict such phenomena. These studies have not progressed too far yet, due to problems that Sargent and Morgan felt were insoluble. Perhaps the earliest attempt to delimit port hinterlands based on statistics other than actual trade movements was by the Turner Report (25) which drew an indifference curve between Toronto and Montreal based on rail and shipping costs, both actual and projected. In 1961, Gould attempted to delimit hinterlands in Ghana by means of the urban field method, using the total value of the trade at the various ports and straight-line distances (26). Draine in 1963 used the rail and ship costs method to delimit a potential import hinterland for Chicago (27), and in 1965 was published Shaffer's efforts

at delimiting hinterlands by the urban field method using tonnages of goods and rail distances (28). It is difficult to know yet whether these works will lead anywhere but it is in the belief that they will that this work is aimed at, finally, predicting potential competitive hinterlands for ports.

Another difference of opinion, related to the differences already noted, is whether or not hinterlands are dynamic or static features. Generally speaking, those who have regarded hinterlands as physical or 'natural' have tended to believe that they are static. The extreme argument for this point of view was put forward by Marcel Amphoux (29). Those who think in terms of statistical hinterlands usually believe that the hinterlands change with time. Morgan has stated that he believes they change in secular periods (29a) but most believe it is much more frequent than that, especially from their observations of the results on trading routes of political upheavals and even of changes in freight rates (30).

One final difference between the various concepts and definitions of a hinterland is whether or not each port has only one or has several hinterlands, (discounting the various commodity hinterlands which are parts of a total commodity hinterland). For example, Seeman and Mayer (31) divide the hinterland into a) the local non-competitive tributary area or immediate metropolitan hinterland; b) the port hinterland proper; and c) the large competitive hinterland. As concepts they are easy to grasp but extremely difficult of demonstration, or even of delimitation.

Morgan, on the other hand, has what he terms a hierarchy of hinterlands, being: primitive; raw material; liner port; and entrepôt hinterlands, as well as recognising primary and secondary hinterlands similar to those of Seeman and Mayer, (32). These again are more dec-

criptive tools -- for example Singapore, being an island, will have a primitive hinterland, a raw material hinterland for its rubber and tin exports, a liner port hinterland from its regular services, and an entrepôt hinterland consisting of much of South-East Asia. Broek (33) has a similar hierarchy in force in Borneo.

A distinction is sometimes drawn between import and export hinterlands and occasionally only one of these will be studied, but normally the two are studied separately then conjoined to form a total hinterland map. For example, Weigend distinguished between imports and exports through Bordeaux, Markham studied only exports and Braine imports, while Matheson studied them both and as a total hinterland (34).

D. Factors Considered Responsible.

Partly as a result of the different views held on the nature of hinterlands but more as a result of the diverse purposes and aims of the various authors, a wide range of factors has been proposed, each of which is supposed to affect the size and shape of port hinterlands. These factors will be studied, not chronologically, in order of first being written down, nor by author, but in groups as they affect the three major factors subsequently selected for the modelling procedure. These basic factors are of land distance, sea distance, and time. A fourth, or miscellaneous, group is appended.

(i) Land distance

Of all the various factors put forward that affect hinterlands, that concerned with land distance has been proposed most often. The earliest article that was found to concern hinterlands stated that "the port most accessible to that hinterland was bound to become the gateway

through which imported goods entered it," (35), (my underlining), and most authors have repeated the same sentiment, though not always as forcefully. Chambers, for example, stated that Houston and Galveston were the major exporters of Texas cotton because they were nearer the cotton-producing areas than were the other ports (36) while Ridout was proclaiming that, as Port Churchill was the nearest port to the Prairies, its future as a grain-exporter was assured (37). Sargent believed that goods would tend to travel through the nearest port, but realised that many complicating factors would disrupt this movement (38) and this has been the generally accepted position held by later authors who attempted then to analyse these disturbing influences.

The first major influence that was discovered, that affected this tendency to ship through the nearest port, was the pattern or network of railroads. Briefly speaking it states that, if an inland area is connected by rail to two or more ports, the imports and exports of that area will be handled by that port which is connected by the shortest railway. Back in 1925 Jones commented that "the importance of Montreal as a grain port is due in a large measure to its location with reference to water and rail routes from the prairie plains of Canada and the corn and winter wheat belt of the U.S.A.," (39), while Hartshorne commented a year later that "a careful study of unpublished statistics of the destination of shipments from country points reveals that within this region the routes .... of railroad companies are of greater significance than the small differences in distance and topography," (40). The majority of those who have since written on this topic have noted this point with the exception of Walker, who believed that the hinterland of Bristol was that area which lay closer

to that port than to any port of comparable size, and Gould who, with his urban field method in Ghana, determined potential hinterlands from straight-line distances (41). In the latter case however this is excuseable in that the rail network was little developed in the period he was testing, with most of the goods being carried by porters. It is surprising however that no one has postulated that the same effect must surely be noted with respect to road systems or canal systems, where the effect of distance must be the same, (42).

Many, however, who have stated that the alignment of transportation, i.e. railway, routes is an important factor have not stated why this is so. Clearly, the reason why goods are expected to follow the shortest route is that, by so doing, they will have to pay the least cost, but not all have realised this or, at least, stated this. Thus van Cleef commented that "the distribution of railroad lines may be such as to make one port more accessible to its hinterland than another and thus cause the diversion of freight from its 'normal' port to the favoured port," nowhere mentioning cost but highlighting accessibility as the major factor (43). A similar set of statements was put out by the Toledo-Lucas County Port Authority: it drew up a potential or possible hinterland map in which Toledo was expected to dominate. The sole criterion was one of rail distance, the costs involved therein not being even mentioned let alone included (44).

The majority of writers have, however, made the point that it is not so much the shortest distance that matters as the lowest cost. J. N. H. Britton has stressed the importance of the actual costs, or freight rates, to the exclusion of actual distances (45) but normally authors have viewed them together and assumed that a shorter route has the

cheaper costs, and admitting that the latter is the more important of the two. Thus Helen Strong wrote that "probably the three most significant elements which influence the routing of traffic are (1) time in transit, (2) the directness of the service, and (3) the freight rate," (46). Others who recognised the importance of freight rates, as opposed purely to rail distances, included Hartshorne, Chambers, Lezius, Seeman, Deprez and Sargent who were all writing in the pre-war period (47). Almost without exception subsequent studies have considered freight rates to be an important factor while the predictions of the Turner Report, Draine, and Shaffer have included this factor, although Shaffer did drop it from his final model, (48).

Although none had mentioned the effect of the factor of road systems on port hinterlands, three writers have commented on the use of road transport freight rates. Weigend stated that the hinterland boundary between Bordeaux and Bayonne was "determined by the land transport costs to each port" (49), which presumably included road costs, but the first to include them specifically was Britton who, in a later article, noted the differences in road and rail freight rates on the same routes (50). The third author was Shaffer who commented on road transport costs and why he was not including them in his model, (51).

Of those that had considered the importance of freight rates, a few noted that they did not necessarily vary regularly with distance, not even with the mileage of the actual route, and so were interested to know why. Several reasons were put forward to explain these irregular rates (which would consequently lead to irregular hinterlands), and the most common of these reasons was politics. The concept of rate-equalisation

is well-known as it applies to the North Atlantic ports but it is a common feature elsewhere too. Seeman commented on the effects of the Interstate Commerce Commission upon Seattle's fortunes, while Deprez noted the effect of the S.D. (Seehafendurchführeneinhändlung) on benefiting German ports at the expense of Antwerp and the Dutch seaports, (52). Deprez also considered that freight rates were affected by mountain barriers and rail gradients while Morgan suspected that individual railroad companies were the main reason for 'non-geographic' rates (53). Shaffer made the point that, although the rates were still basically the same, the Mozambique railways would charge an extra rate, equivalent to a customs duty, on goods from the Transvaal exported through Laurenco Marques, another instance of political effects on freight-rates, (54). Occasionally these authors remarked that such factors directly affected the size and shape of port hinterlands but this, of course, is not true -- these factors are indeed of importance but work only indirectly by being one factor amongst many that affects land transport costs.

(ii) Sea distance.

The second major group of factors that determine the size and shape of a port hinterland are those connected with the maritime aspects of trade. In the way that Crawford, Chambers, and Sargent spoke of the factor of land distance (supra), nobody has suggested the factor of sea distance which in a sense would mean the minimisation of maritime distances and costs. This seems all the more surprising when one considers that a large group of goods, characterised by mail and perishables, are often in the hinterland of that port which has the shortest journey across the water -- a good example of this being the packet ports of Dover and

Calais which command national hinterlands for certain commodities.

Nor have authors considered maritime routes as opposed to straight-line distances, but much has been written on the aspect of shipping costs, costs, as we saw in the previous section, having been shown to be the important factor which is itself by many things affected. C. F. Jones was one of the first to remark on shipping costs when he stated that Montreal was well-positioned with respect to ocean freight-rates while Lezius realised Toledo's advantageous position with respect to freight-rates into and beyond Lake Huron, providing of course that they were proportioned to distance and not equalised (55). Although it was stated just now that some goods tend to minimise the sea journey, Daniel Hoan commented that "it is a natural law of water transportation that ships will penetrate inland as far as possible before discharging their cargoes, to extend the benefits of low cost water transportation to the farthest point," (56). The existence of Calais and Dover seriously test the validity of his law, but the important point he stresses is the cost of shipping, a point which Sargent and many other studies of hinterlands appear to have forgotten, having ceased their studies at the water's edge. Of others who have used shipping costs to assist them in their understanding of the size and shape of hinterlands, Mayor and Dreine are outstanding while the Turner Report and Britton also used them in their studies (57).

As with the terrestrial section, people have noticed that marine freight rates are not always proportionate to distance, as is expected, and have attempted to explain such facts. Many answers have been forwarded, and not all of them by studies of hinterlands but they have assisted our

knowledge of how shipping rates are composed. The earliest contribution in this field was from E. J. Gregg in 1922 when he explained many freight-rate anomalies by the lack of return cargoes at ports, so that a higher rate is charged on goods destined to a port from which little return cargo is expected (58). Many writers have since commented on this fact.

Other factors that have been put forward as important are the costs to a shipowner of navigating an estuary, both in the time involved and the extra costs of pilotage (59); congestion and rapids on rivers (60); and competition between carriers or shipowners (61).

The main factor here however is that concerned with port charges. There could be some dispute as whether or not to include it in the terrestrial or the marine section, but it was decided to include it here because the majority of port charges are borne by the shipowners who then pass it on as increased freight-rates to the shipper of goods. As is usual, C. F. Jones was about the first person to remark upon its effect on routeing trade though again, as usual, he referred to port charges only briefly. He realised their importance but did not show how or why they influenced trade (62). Sargent phrased it that "one port may push back the natural joint boundary of their hinterlands through the provision of better shipping or storage and marketing facilities", later referring to the whole group as port facilities (63). Generally speaking it is now recognised that the more facilities a port has the cheaper it is to shipowners because they need to spend less time in port.

Having seen that port charges affect shipping rates and therefore costs and therefore the size and shape of hinterlands, many geographers have concerned themselves with studying the provision of port facilities,

which affect port charges, but not followed it through to see how the provision of these facilities affects the hinterland. Normally they restrict comments to such statements that the provision of better facilities by any one port will tend to increase its hinterland. This is probably true but we should be more interested if they could tell us how big an extension would result from a certain input of facilities. As Shaffer puts it: "that port installations and amenities are an important consideration to the consignor, consignee and carrier of goods is well-known". The amenities he then ~~considers~~ studies are berthage, sheds, handling facilities and depth of water (64).

A similar consideration comes from Gould's and Shaffer's attempts to delimit hinterlands by using the amount of trade handled by the port as the basis (65). The correlation between the two is close, but it is only a correlation, not a cause and effect. The factor that caused the larger trade volume would also cause the increased size of the hinterland. However an interesting point was derived from this aspect by W. S. Bayley who commented that, as the Atlantic coast ports are so large, "they therefore afford much better opportunities for disposing of miscellaneous cargoes than any point in the lake district and can furnish return cargoes as well," (66), thus effecting a saving in cost by way of port charges and shipping costs.

(iii) Time.

The third major group of factors to be considered is that concerned with the costs of time to a shipper. None have told us how to measure the cost of time, or even how to measure time itself, but many geographers have intimated that time is an important factor and that a

shipper if faced with two alternative journeys at the same price would take the quicker of the two. This is all that we know, except that they often tell us where we can expect to find time differentials.

The earliest quotation is that of Helen Strong already given (supra) which stressed the importance of time in transit, or total time. Sargent realised the importance of time when he noticed that goods would often be carried along the coast by rail or truck, despite the fact that a ship could accomplish the task for less cost (67). Deprez was of the opinion that Antwerp was the 'natural' port for Anglo-Czechoslovakian trade "car il est certain que la voie la plus directe et la plus rapide passe car chez nous," (68) but that the cheap rates to Hamburg more than counteracted this.

In a similar vein, V. B. Smith commented on the difference in time from shipping directly between Chicago and Liverpool, and shipping via the Atlantic coast -- one of the few to actually measure time (69), while Weigend explained that Hamburg's hinterland was being diminished by the severe road bottlenecks experienced in crossing the Elbe and the generally poor nature of the roads to the south compared to the Autobahnen of Central and Southern Germany (70). The time taken in transit was also taken into account by Braine in formulating his hinterland for Chicago but he did not attempt to measure its possible effect (71).

The time taken on each journey is of importance to the shipper, but possibly of greater importance is the frequency with which such journeys operate. When trying to explain the relative positions of two or more ports, one of the major reasons nearly always given to explain the success of the larger is that it has a better frequency of services.

This again is a correlation, not a cause and effect, but those ports that have the better services have the larger hinterlands and this appears to be a spiral movement, each assisting the other up, or down. A contracting hinterland can lead to a decline of services which would give a further contraction of the trading area, and so on. Almost all writers have 'explained' hinterlands in these terms, that is to say correlated them, but none have said anything more than that in this way the shipper saves time. However if this alone were so, all trade would be concentrated into two or three ports and not eighty-seven as in Ontario.

A point that is much less discussed, however, is the destinations with which these services connect. Deprez was the first to comment on it, noticing that for the North American trade Antwerp had most to fear from Hamburg, while Marseilles and Genoa were the strong contenders for the eastern trade (72). The only other person to notice its important effects was Bird. Remarking upon the fact that the West Riding of Yorkshire obtains its Australian and Argentinian wool through Southampton and not through the larger, and nearer, ports of Hull and Liverpool, he wrote: "the regularity of a liner service to a port's 'foreland' overseas is a powerful routeing factor. It generally overrides questions of internal distance in the relatively small island of Britain or any question of competing port hinterlands," (73). Bearing this in mind it is remarkable that no one else has considered the different services that each port can provide rather than looking simply at the total number of scheduled sailings.

Again, few people have looked at frequency as it applies to land

transport, especially railways, although notable exceptions are Chambers, Mayer, and Britton: Britton indeed further ventured the point that a set frequency of land services was more important to a shipper than an identical frequency of coastal sailings by vessels because the departures and arrivals by land were much more dependable and less subject to day-long hold-ups,(74).

Another point that has not been too frequently made is that different goods react to the same cost and time conditions in different ways. Generally speaking it has been observed by many that cheap, heavier goods travel more slowly and at less expense than expensive, light goods. Sargent realised this but could not explain it (75) while Morgan realised that somehow it was connected with the weight/value ratio of the good, hinterlands increasing in size and decreasing in number as the weight/value ratio declines, (76). Marion Matheson brought out the fact well that, "within this hinterland, more expensive [forestry] goods are moved the greatest distance to St. John for export" and based this on the belief that more expensive goods could withstand higher rates (77). Very few others have dealt with this problem; Braine, for example, stated that the nature of the cargo was an important routeing factor but declined to incorporate it into his calculations (78). One of the tasks that this thesis intends to attempt is to formulate a method by which time can both be measured and ascribed a cost.

(iv) Miscellaneous.

This section includes many other factors that have been put forward in an attempt to explain the observed sizes and shapes of port hinterlands. Surprisingly enough, one factor that was rarely referred to

was the factor of relief, of mountain barriers, and so forth: as we have seen, Sargent and van Cleef believed that physically controlled hinterlands are conceivable, although not found in reality, while Brock noticed that the hinterlands of Borneo correlated fairly closely with mountain ranges (79), but only Seeman has expressly stated that a mountain range per se has formed a hinterland boundary. In speaking of the possible hinterland for Seattle he claims that "near the Oregon-California State line the topography becomes so rugged that it is not feasible to ship commodities northward for exportation; this topographic feature marks the southern boundary at that place," (80); the correlation he claims may well be there but it will only be an indirect result of the topography, the latter possibly affecting transportation routes and costs, but not directly the size and shape of the port hinterland. (That mountain ranges do not always delimit traffic can be shown by reference to the 14m. tons of prairie grain annually exported through Vancouver).

One interesting point that several authors have drawn attention to is the effect on the size and shape of hinterlands of the number and spacing of ports in any given area or along any given coastline. Sargent referred to the problem of extra, smaller ports intervening between the larger ones and disturbing the general pattern of hinterlands by competing successfully for a few commodities only (81). However, it is more likely that the reverse is nearer the truth; that all of those ports started off as equals but that some slowly grew at the expense of others, capturing the trade of the lighter commodities and concentrating the facilities required for those commodities. It is really the larger

ports that are disturbing his conception of the geographical hinterland. An interesting example of this is shown in Andrews' case-study of Chepstow in which he analysed the history of that port's loss of trade to neighbouring ports as being the result of improved communications and lower rates, which tend to have the effect of reducing the distance between any two ports (82). The same point was noted by van Cleef when he stated that "the hinterlands of the Baltic ports of Finland are small, owing to the long coast-lines, [and] the numerousness of the ports ...," (83).

A further geographical factor that relates to the distribution of hinterlands is the factor of seasonality. Sargent commented that "ports may ship from the same area ... at different times, regardless of comparative costs of mere rail transport," (84) though he did not say under what circumstances this would happen, while Bird illustrated one reason for this: "the sailing of the right ship at the right time to the right overseas port is a potent factor cutting across any hinterlands based on actual distances," (85). This is taking seasonality to refer to very small time periods, but the usual effect noted is that of different summer and winter hinterlands as a result of ice. Most Canadian and many American geographers have referred to this fact, but those whose experience of ports has been of those with year-round port operations, notably the British, have tended to forget that this has a potent effect on the shape and size of the hinterlands of adjacent year-round ports. The best work that illustrates such an effect is that of Matheson (86).

A final geographic factor, as opposed to the following economic and human factors, that has occasionally been considered important in determining the size and shape of port hinterlands is that which may be

termed the nature of the hinterland. Normally it is referred to as one of the reasons for the size and nature of the port -- thus Lezius attributes some of Toledo's greatness to "the copiousness of its coal-producing hinterland", without saying how this hinterland was obtained (87), and Kerr and Spelt refer to Toronto's "large ready-made consumer and producer market" as affecting Toronto's possible hinterland (88). Guido Weigend has however stressed "the importance of such other vital factors as ..... agricultural, industrial, and urban development in the interior or overseas areas", (89) as affecting the size and shape of the hinterland. This in effect is saying that if a port has an industrial hinterland, it will benefit the port, which will provide more and better facilities and thus enlarge its hinterland, which is, in any case, a very indirect effect. Even so, allowing for this possibility, it has often been noticed that an internal area of high productivity usually becomes the scene of very severe competition between ports which would tend to reduce any one port's extension of its hinterland -- Shaffer illustrates this well with respect to port competition for the trade of the Transvaal (90). The mere existence of a populous or highly developed area does not necessarily mean that it will all fall into the hinterland of any one specific port, and therefore improve that port and its hinterland, although of course it is quite possible that it will. The point that should be stressed however is that it would have, at any rate, only a very indirect influence upon the further development of that hinterland.

Of the additional economic factors that have been proposed as affecting the routeing decisions of shippers, and thus port hinterlands, the most interesting one is that of the factor of insurance. The only

writer who mentioned this factor was C. F. Jones, in 1925, when he clearly showed the influence of this factor on the routeing of grain shipments from the mid-west, and especially how geographic considerations affect the setting of insurance premiums (91).

The factor of port charges has already been dealt with in connection with the factor of sea distance, but some evidence has been put forward recently in geographic literature to suggest that not all port charges are handed straight on to the shipowners but that some are payable directly by the consignor himself. This evidence, from Shaffer (92), was based on figures collected from various port authorities in South Africa and shows that port charges not only vary from port to port in total amount but also vary in the percentages paid by the shipper and the shipowner. Normally storage and stevedoring charges will be payable by the shipper though, again, this varies. However, although it is an additional cost to the shipper in that it is not included in either the land or the marine freight rates, Shaffer is of the opinion that the differences involved are too small to have any noticeable effect.

Similarly, the factor of politics has already been discussed with relevance to rail rates but there is evidence that politics affects routeing decisions in other ways too. Thus Morgan referred to the Franco-Belgo-Netherlands Treaty of 1939 which arbitrarily fixed the limits of 18% and 24% of all Rhine traffic that could pass through the Belgian ports (93), while the effect of tariffs and quotas upon trading has been widely noticed. Shaffer commented that 'specific advantages' to ports "may result from the application of external policies, i.e., governmental policies with regard to port development, orientation of traffic or port

utilisation, protection of vested interests or by international agreements," (94). It must be remarked upon here however that, except under the conditions of a totalitarian economy, governments are not able to force businessmen to make specific routeing decisions; which therefore means that they must offer bribes in the form of reduced charges, charges which can be obtained without recourse to the political motives behind them.

A further set of factors are those relating to the possible routeings of goods by a way that is not the most economic, or apparently so. Thus Seeman thought that, although freight rates from a given place were lower to Seattle than to Portland, grain still went to Portland because that was the location of the main office of the line of elevators locally engaged in shipping grain (93), which effected a total saving in costs. Sinclair referred to the internal economies of firms affecting the size and shape of hinterlands -- for example, two importers at different ports would receive the same commodity at the same price; however, one, by internal economies, could distribute these goods more cheaply, this resulting in an extension of his hinterland, and that of that port, at the expense of the other (96). Kerr and Spelt conducted an enquiry amongst Toronto industrialists before writing their article and came to the conclusion that trading inertia was quite prevalent -- "our firm has shipped through Montreal for thirty years and has had no problems; we will continue to maintain the relationship in the foreseeable future, although a slight saving in cost might be realised by shipping directly at Toronto" being sentiments often expressed (97). Similar features they recounted included the fact that branches of firms may not ship

their goods so as to maximise their own profit as much as to maximise the ~~rights~~ profits of the company as a whole, which may maintain its own port installations elsewhere (98).

Finally, various authors have considered the importance of the human factor, especially in so far as the businessman is capable of making uneconomic decisions. Albion, Kerr and Spelt, and the Turner Report all stress the possibility of advertising by the ports influencing businessmen to ship their goods a more expensive way (99) while van Cleef suggested that "other dislocations in port hinterlands may arise from ... conflicts in nationalistic ambitions, or because of linguistic differences, or antagonisms growing out of differences in ethnic, cultural or historical backgrounds. The momentum of trade habits or movement of goods and people via long-established routes .... all contribute to the shaping, or re-modelling, as it were, of hinterland areas," (100).

As with almost all of these miscellaneous factors the authors give us no method as to how to measure these factors, let alone the effect such factors will have upon the size and shape of port hinterlands. In a sense it is only surmised that these factors actually affect hinterlands, it has never been proved that in fact they do.

(v) Summary.

The main conclusion to be drawn from this section is that there has been a wide range of factors put forward to account for the nature of hinterlands. As was suggested beforehand, in very few cases have reasons been given to support the beliefs in the efficacy of such factors, and in even fewer cases have they actually been proven to be of importance.

The factors that have been selected in chapter IV in assisting

with the predictive model have all been mentioned by various authors before; no new factor has been proposed. The important point to note however is that no one author has considered all the factors that will be considered, and yet the final list is remarkably ~~so~~ short. Thus Sargent, who gave the fullest list of all land factors, dwelt very little on the maritime effects, while Bird was the exact opposite. The nearest that anybody has come so far to the simple list of factors mentioned later was Helen Strong who, in one sentence, summed up much of the nature of routeing decisions: "Probably the three most significant elements which influence the routing of traffic are (1) time in transit, (2) the directness of the service, and (3) the freight rate," (101).

Footnotes to Chapter II

(1) A. J. Sargent, Seaports and Hinterlands, (London: Black, 1938); F. W. Morgan (A), Ports and Harbours, (London: Hutchinson, 1952); J. Bird, The Major Seaports of the United Kingdom, (London: Hutchinson, 1963).

(2) Sargent, op. cit., p. V.

(3) M. Matheson, "The hinterlands of Saint John", Geographical Bulletin, VII (1955), 65-102; I. E. Muddle, "The suitability of the port of Dover as an outlet for its developing hinterland", Geographical Journal, LXXXIII (1934), 503-512; J. Deprez, "Le port d'Anvers, des zones d'influences et son trafic", Bulletin de la Société Belge d'Études Géographiques, VIII (1938), 182-229 and IX (1939), 33-115; P. Camu (A), "Le port et l'arrière-pays de Trois Rivières", Geographical Bulletin, I (1951), 30-56; G. G. Weigend (A), "Bordeaux, an example of changing port functions", Geographical Review, XLV (1955), 217-243; G. G. Weigend (B), "The problem of hinterland and foreland as illustrated by the port of Hamburg", Economic Geography, XXXII (1956), 1-16; Drs. R. C. Harkema, "Het Achterland van Zanzibar in de tweede Helft van negentiende Eeuw", Tijdschrift voor Economische en Soziale Geographie, LV (1964), 42-48.

(4) W. T. Chambers, "The Gulf port city region in Texas", Economic Geography, VII (1931), 69-83; F. W. Morgan (B), "The pre-war hinterlands of the German North Sea ports", Transactions of the Institute of British Geographers, XIV (1948), 43-56; F. W. Morgan (C), "The pre-war hinterlands of the German Baltic ports", Geography, XXXIV (1949), 201-211; E. van Cleef, "East Baltic ports and boundaries with special reference to Königsberg", Geographical Review, XXXV (1945), 256-272; G. G. Weigend (C), "Austria's ports", Geographical Review, LI (1961), 132-134.

(5) E. H. Draine, Import Traffic of Chicago and its Hinterland, Chicago University Geography Department Research Paper no. 81, (Chicago: Chicago University, 1963).

(6) O. G. S. Crawford, "Prehistoric geography", Geographical Review, XII (1922), 256-262; R. G. Albion, "New York Port and its disappointed rivals, 1815-1860", Journal of Economic History and Business Review, XII (1932), 602-629; R. W. Harbeson, "Transportation developments and the North Atlantic ports", Harvard Business Review, XII (1933), 82-93; McGill School of Commerce, Impact of the St. Lawrence Seaway Project on the Montreal Area, (Montreal: Montreal Research Council, 1958), (The Turner Report); A. Spoehr, "Port town and hinterland in the Pacific Islands", American Anthropologist, LXII (1960), 586-592

(7) A New English Dictionary, (Oxford: Oxford University Press, 1893), vol. H-J.

(8) A Glossary of Geographical Terms, ed. L. D. Stamp, (London: Longman Green, 1961), p. 235. This quotation is taken from the unpublished Dictionary of Geographical Terms perpared by Hugh Mill for the Royal Geographical Society between 1900 and 1910.

(9) Sargent, op. cit., p. 3.

(10) Crawford, op. cit., p. 259.

(11) D. G. Ridout, "Port Churchill", Canadian Geographical Journal, III (1931), 105-128.

(12) L. Mecking, Japans Häfen, ihre Beziehungen zur Landesnatur und Wirtschaft, (vol. XLII (1931) of Mitteilungen der Geographischen Gesellschaft in Hamburg).

(13) R. G. Albion, op. cit.

(14) Sargent, op. cit. p. 4. (15) Ibid., p. 5. (16) Ibid. p. 175.

(17) F. Walker (a), "The port of Bristol", Economic Geography, XV (1939), 109-124; F. Walker (B), "Industries of the hinterland of Bristol", Economic Geography, XXIII (1947), 261-282.

(18) E. van Cleef, op. cit., p. 257-258. (19) Ibid., p. 258.

(20) M. Matheson, op. cit.

(21) J. O. M. Broek, "The ports of Borneo", Annals of the Association of American Geographers, XLVII (1957), 154-155.

(22) A. Spoehr, op. cit.

(23) F. W. Morgan (B), op. cit.; F. W. Morgan (C), op. cit.; G. G. Weigend (A), op. cit.; G. G. Weigend (B), op. cit.; N. M. Shaffer, The Competitive Position of the Port of Durban, Northwestern University Studies in Geography no. 8, (Chicago: Northwestern University, 1965).

(24) M. Matheson, op. cit. (25) The Turner Report, op. cit., p. 93.

(26) P. R. Gould, Transportation in Ghana, Northwestern University Studies in Geography no. 5, (Evanston: Northwestern University, 1961), appendix A.

(27) Draine, op. cit. (28) Shaffer, op. cit.

(29) M. Amphoux, "Cadre geographique et fonctions portuaires", Revue de la Porte Oceane, VI (September 1950). Quoted in Weigend (B), op. cit., p. 2-3.

(29a) F. W. Morgan (C), op. cit., p. 211.

(30) E. G. see C. F. Jones, "The grain trade of Montreal", Economic Geography, I (1925), 53-72.

(31) A. E. Seeman, "Seattle as a port city", Economic Geography, XI (1935), 20-32, esp. p. 21; H. Mayer, The Port of Chicago and the St. Lawrence Seaway, Chicago University Geography Department Research Paper no. 49, (Chicago: Chicago University, 1957), p.120.

(32) F. W. Morgan (A), op. cit., p. 112-16. (33) J. C. M. Boek, op. cit.

(34) G. G. Weigend (A), op. cit., Drs. R. C. Harkema, op. cit., E. H. Draine, op. cit.; and M. Matheson, op. cit.

(35) O. G. S. Crawford, op. cit., p. 259.

(36) W. T. Chambers, op. cit., p. 73. (37) D. C. Ridout, op. cit.

(38) A. J. Sargent, op. cit., p. 176. (39) C. F. Jones, op. cit., p.54.

(40) R. Hartshorne, "The significance of lake transportation to the grain traffic of Chicago", Economic Geography, II (1926), 274-291; p. 276.

(41) F. Walker, (A), op. cit., p. 121; P. R. Gould, op. cit., appendix A.

(42) For the fullest expansion of the factor of railway routes see Sargent, op. cit., p. 9-13.

(43) E. van Cleef, op. cit., p. 258.

(44) Port of Toledo, Ohio, U.S.A., (Toledo: Toledo-Lucas County Port Authority, 1965) p. (3).

(45) J. N. H. Britton, (A), "The transport functions of the port of Port Kembla", Economic Geography, XXXVIII (1962), 347-358.

(46) H. M. Strong, "Changes in entrepôt markets for tropical and other exotic products", Annals of the Association of American Geographers, XV (1925), 180.

(47) R. Hartshorne, op. cit., p. 276; W. T. Chambers, op. cit., p. 75; W. G. Leziug, "Geographic aspects of coal cargoes from Toledo", Economic Geography, X (1934), 374-381; A. E. Seeman, op. cit. p. 22; J. Deprez, op. cit., VIII (1938), p. 192; A. J. Sargent, op. cit., p. 9.

(48) The Turner Report, op. cit., p. 93; E. H. Draine, op. cit., chapter three; N. M. Shaffer, op. cit., p. 223-226.

(49) G. G. Weigend (A), op. cit., p. 237.

(50) J. N. H. Britton (B), "Interstate transport competition and the port of Melbourne", Australian Geographical Studies, I (1963), 84-95.

(51) N. M. Shaffer, op. cit., p. 127. The reason given is that, for political reasons as well as poor roads, the average truck haul in South Africa is ten miles, and is insignificant from the point of view of continental hinterlands.

(52) A. E. Seeman, op. cit., p. 26; J. Deprez, op. cit., VIII (1938), p. 213.

(53) J. Deprez, op. cit., VIII (1938), p. 210; F. W. Morgan (A), op. cit., p. 122.

(54) N. M. Shaffer, op. cit., p. 51.

(55) C. F. Jones, op. cit., p. 54; W. G. Lezius, op. cit., p. 378.

(56) D. W. Hoan, "The St. Lawrence Seaway, navigation aspects", Canadian Geographical Journal, XXXVI (1948), 52-69.

(57) H. Mayer, op. cit.; E. H. Draine, op. cit.; the Turner Report, op. cit.; J. N. H. Britton (B), op. cit.

(58) E. S. Gregg, "The influence of geographic factors in ocean shipping", Geographical Review, XII (1922), 424-450.

(59) discussed in W. T. Chambers, op. cit., concerning the imports into Houston being more expensive than via the outport of Galveston; and N. J. G. Pounds, "Port and outport in North-West Europe", Geographical Journal, CIX (1947), 216-227.

(60) The Turner Report, op. cit., discusses in detail the various components of the cost of running a ship, most of which are non-geographic.

(61) Ibid.

(62) C. F. Jones, op. cit., p. 54. (63) A. J. Sargent, op. cit., p. 176.

(64) N. F. Shaffer, op. cit., p. 34-35.

(65) P. R. Gould, op. cit.; N. M. Shaffer, op. cit.

(66) W. S. Bayley, "The geographic effects of the proposed Great Lakes - St. Lawrence Waterway", Economic Geography, I (1925), 236-246; p. 239.

(67) A. J. Sargent, op. cit., p. 6. (68) J. Deprez, op. cit., VIII (1938), 213.

(69) V. B. Smith, "Overseas trade on the Great Lakes", Journal of Geography, LIV (1955), 327-337.

(70) G. G. Weigend (B), op. cit., p. 8. (71) E. H. Draine, op. cit.

(72) J. Deprez, op. cit., VIII (1938), 212. (73) J. Bird, op. cit., p. 178.

(74) W. T. Chambers, op. cit., p. 71; H. Mayor, op. cit.; J. H. H. Britton (B), op. cit.

(75) A. J. Sargent, op. cit., p. 6. (76) F. W. Morgan (A), op. cit., p. 114.

(77) H. Matheson, op. cit., p. 70. (78) E. H. Draine, op. cit.

(79) A. J. Sargent, op. cit., p. 4; E. van Cleef, op. cit., p. 258; J. O. M. Broek, op. cit., p. 155.

(80) A. E. Seeman, op. cit., p. 24. (81) A. J. Sargent, op. cit., p. 16.

(82) J. H. Andrews, "Chepstow: a defunct seaport of the Severn Estuary", Geography, XL (1955), 97-107; esp. p. 106.

(83) E. van Cleef, op. cit., p. 259. (84) A. J. Sargent, op. cit., p. 176.

(85) J. Bird, op. cit., p. 94. (86) H. Matheson, op. cit., p. 90.

(87) W. G. Lezius, op. cit., p. 377.

(88) D. Kerr & J. Spelt, "Overseas trade at the port of Toronto", Canadian Geographer, VIII (1956), 70-79.

(89) G. Weigend (B), op. cit., p. 2. (90) N. M. Shaffer, op. cit.

(91) C. F. Jones, op. cit., p. 57. (92) N. M. Shaffer, op. cit., p. 51-56.

(93) F. W. Morgan (A), op. cit., p. 121. (94) N. M. Shaffer, op. cit., p. 4.

(95) A. E. Seeman, op. cit., p. 28.

(96) R. Sinclair, "Coal port hinterlands of Northern Ireland", Annals of the Association of American Geographers, XLVII (1957), 178.

(97) J. Kerr and J. Spelt, op. cit., p. 77. (98) Ibid.

(99) R. G. Albion, op. cit., p. 626; D. Kerr and J. Spelt, op. cit., the Turner Report, op. cit., p. 98.

(100) E. Van Cleef, op. cit., p. 258-259. (101) H. Strong, op. cit., p. 180.

CHAPTER III

DEFINITION OF TERMS

A. Hinterland

It should have become apparent from the points raised in the last chapter that, before we can proceed to reason the shape and size of a hinterland, we must possess an exact definition of this phenomenon that not only describes as accurately as possible what a hinterland is, but is also scientific enough for us to apply. For example, a definition of a hinterland as 'that area dependent upon a port' may describe very well what a hinterland is, but is useless in that we cannot allocate points to a given hinterland until we know how to measure 'dependence'. Similarly, a scientific definition is not enough -- one could postulate that "all points nearer in straight-line distances to one port than to any other port are in the hinterland of that port" and it would be extremely easy to allocate the land into various hinterlands, the problem being of course that it would not really represent the feature that we wished to study. Therefore a definition must be used which will satisfy both these requirements as far as possible.

Most of the definitions studied in chapter two will have to be discarded or modified as they are not scientific or accurate enough, whereas others, such as the belief in physiographic hinterlands of estuarine ports delimited by mountain ranges and watersheds, do not represent hinterlands as most people view them. The general consensus

of opinion about hinterlands being that they are economic phenomena although spatially observable confirms the author's belief that an economic definition is required. As all movements of goods are the result of economic decisions (though many are tainted admittedly with irrational, uneconomic modifications) then a hinterland, which can be viewed as merely a result of the summation of such decisions, can also be considered an economic phenomenon, and definable as such.

The definition finally decided upon owes much to the definition given by Mill who called a hinterland "that region the seaborne trade of which belongs to a particular seaport or seaboard", (1). It is felt that this lays the correct emphasis on the relationship of a port to its hinterland but is lacking in scientific accuracy. The definition eventually chosen was: a hinterland is that region the waterborne trade of which yields, in any given time period, more revenue to one particular port than to any other. From this definition it would appear that the author's conception of hinterlands was one where no overlapping took place, for it is a necessary corollary from the above that each region is allocated to only one port. However, the author would be the first to agree that such happenings are unlikely in practice, any area shipping through several if not many different ports. The difficulty is that, unless one defines a hinterland as to include all areas that ship through a port, it is extremely difficult to obtain a meaningful definition without dividing the subject into primary, secondary, and tertiary hinterlands with arbitrary division lines (2) thereby disrupting the belief that there is only one hinterland.

It is now necessary to further elaborate and define five of the

elements of the above definition, namely 'region', 'waterborne', 'time period', 'revenue', and 'port' in order to fully comprehend the nature of the above definition.

B. Port

It must be made clear what is to be understood by the use of the term 'port'. The necessary function of a port which sets it apart from all other phenomena is considered to be the transference of goods between land and waterborne vessels and so a port is defined as any place where this function is fulfilled. Thus there is seen to be no difference whatsoever between the economic function of a privately-owned wharf on the Welland Canal and the port of Toronto: both transfer goods between ship and shore and so both are classified as ports. Unfortunately there is no one word which will conveniently embrace the whole continuum stretching from a 'super-port' to a wooden jetty so it was decided to follow the tradition set by most other writers on the subject and to term them all as 'ports'.

It may be argued that there is a distinct break in the continuum between those ports which offer handling facilities, notably cranes and elevators, and those that do not, but this is not a very useful division. For example, Whitby, Ontario, unloaded over 28,000 tons of commodities in 1963 without the aid of any cranes or handling equipment of its own, whereas Meaford, Ontario, quite well-equipped as regards handling facilities, had no trade at all (3). The reason for this is that, although the provision of handling and other facilities is a useful asset to the port, its presence or absence is not enough to determine the importance of the port, mainly as the result of the fact that most cargo

vessels can unload themselves with their own winches, a process that merely takes longer where there are no port facilities to assist. As an additional point it would be extremely difficult to know where to draw the dividing line between ports with facilities and those without: in some parts of the world a man-powered winch or even a concrete wharf may be considered as 'facilities'. Any such division would have to be arbitrary and refer only to the area being studied.

Nor is there considered to be any real distinction between private ports and public ports, mainly because they fulfil the same essential function. The hinterlands of private wharfs tend to be extremely restricted as in most cases incoming goods are destined for processing at the coastal site and outgoing goods originate at the same place. However, much of the trade of a large public port is also of the same nature, many of the goods being processed at the coastal side, apart from which much of the wharfage in any large port is privately owned and controlled.

There is also the question of whether or not to include certain specialised ports under the general heading of 'ports'. Firstly there are those ports whose sole function is the despatch and reception of ferry boats across a sea, an estuary, or even just a lake or a river. Logically there is no difference between these and other ports as they fulfil the same necessary function, but the services provided at ferry ports are of one link only, normally, acting just as a road bridge or a tunnel to connect two places and capable of being displaced entirely by the provision of one of these. Nevertheless, such ports are to be included for they may well carry large quantities of goods, as is

evidenced by the ferries around the shores of the British Isles, and as a result will have definable hinterlands.

The inclusion of those ports that receive or ship goods from or to the sea, and not from or to other ports (notably fishing ports) will be discussed in section F of this chapter.

The major problem connected with the definition of the term 'port' is the question of its territorial limits. Normally no worry attaches to this as most ports are clearly delimited features, widely spaced, but in Ontario alone there are eleven pairs of ports that are remarkably close to each other (4) and normally of equal importance. The question is whether to treat any of these pairs as a single port, with a correspondingly increased hinterland, or as separate ports. Some of these pairs have now joined forces - notably Fort William with Port Arthur, and Walkerville with Windsor - and are controlled by one authority, so presumably these can now be recognised as one unit each. As for the others, there appear to be two major ways of deciding whether or not to treat them separately.

Firstly one could decide whether or not they formed one port by using a distance concept such as that if there is less than, say, two miles of unwharfed land between the two sets of installations then they should be treated as one port. The disadvantage is immediately seen here in that it is difficult to obtain a figure that would work under all circumstances, in all locations and at all time periods. One would have to subjectively decide for each pair of ports whether or not they constituted a single port (5), for one could not expect the same mileage figure to be meaningful in both Northern Germany and Labrador. A constant could be

envisaged such as that two ports are to be considered separate if one cannot reach one from the other in less than, say, 20 minutes. This would allow for variations between lands with good lateral communications and those without, but the difficulty still remains in finding a useful standard.

The other obvious alternative (of deciding whether or not to classify two ports as one) is to decide according to port authority or ownership. Problems, however, exist with this too. Consider for example the six separate port installations at Port Colborne, Welland, Thorold, Homer, Port Weller, and Port Dalhousie -- all of these are controlled by the St. Lawrence Seaway Authority and, if resultantly classified as one port, would form a single port system of 28 miles in length. The D.B.S. treats them as four ports, amalgamating Port Weller, Port Dalhousie and Homer to form the Port of St. Catherines, but does not include Thorold therein although the break between Thorold and Homer is less than that between Ports Weller and Dalhousie. Even with knowledge of the six sets of installations it still becomes difficult to know whether or not to treat them as one, four, or six ports.

It was decided eventually to define a port as that grouping of installations that are under the control of an independent harbourmaster or, if there is no such authority, they are to be grouped under municipal boundaries. In many cases the existence of a separate harbourmaster is sufficient to classify the installations under his control as one port. However, there is no one harbourmaster to look over the installations of the Welland Canal, so these are treated as the four separate ports of Port Colborne, Welland, Thorold and St. Catherines, delimited by the

town boundaries. There is no basis for this arbitrary classification, it is true, but it does receive some support from the fact that trucking and railroad companies would charge rates according to the town of destination rather than to the actual location of the installation which means that they too would treat Homer, Port Weller and Port Dalhousie as one port, but Thorold as a separate entity.

C. Revenue.

Originally it had been intended to use as the definition for hinterland "that region the waterborne trade of which, for any given time period, is handled more by one particular port than any other", but this was seen to lead to the following difficulties. Hill's definition, it should be remembered, stated that the hinterland was "that region the seaborne trade of which belongs to one particular seaport or seaboard". Although this is in many ways an excellent definition for our purposes, subsequent hinterland case studies had revealed that no area ships exclusively to and from one particular seaport or even one seaboard, often not even from the port town itself. This fact had already led to some rethinking on the matter. In 1938 Sargent noticed that no such monopolies were held by ports, but added that it was "evidently possible to draw a line in such a way that in the area so enclosed, 70 percent or any other percentage of imports or exports, measured by volume or by value, is handled through the port", (6). This is true, such a line could be drawn, but perhaps a better line could have been drawn. The difficulty lies, of course, in finding a satisfactory percentage figure applicable in all places at all times. If for instance, the line was set at 51% there would be bound to be some ports that would

ship 10% of their goods through each of seven ports and 30% through one other. If the figure was reduced to 30% there would no doubt also be ports that would ship 40% of their trade through each of two ports. The only satisfactory way of solving this is to say that an area is in the hinterland of a certain port only if it ships more through that port than through any other, thus ensuring that each point will be in the hinterland of one port and of one port only, except where two or more ports share the highest percentage, putting that place on a watershed or indifference line between them.

Sargent raised a very difficult problem however when he stated that 'more' could be measured either by value or volume of the goods. If we are studying only one commodity the distinction is unimportant for the value and volume will be in relatively constant proportions, but in the determination of combined commodity hinterlands, very serious problems arise.

Consider a hypothetical area R which has no other maritime trade except the receiving of 400,000 tons of bulk materials, valued at $4 m., through Port S, and 100,000 tons of general cargo, valued at $100 m., through Port T. The definition given at the head of this section is incapable of the determination of which port region R is in the hinterland -- if it is more by volume, then it is in the hinterland of Port S, if by value, then port T. The problem is insoluble without additional facts to assist us for no one could, by studying the trading movements only of R, S and T, put R into either of those hinterlands.

Extra information is therefore required and it is suggested that this is obtainable from the port authorities themselves. To them the

importance of handling goods for an area lies not so much in the actual value of the goods nor in the weight of the goods but in the revenue they obtain from handling them. Thus, if handling 100,000 tons of general cargo brought in a revenue of $100,000 while 400,000 tons of bulk materials cost the shippers $40,000, then the port would be more willing to accept the general cargo consignment, enabling us to place R in the hinterland of T. If however R shipped the same amount of general cargo through T but now received 1,200,000 tons of bulk materials through S, the total value of which being still only $12 m., then the revenue to port S of $120,000 would make its trade with R more valuable than R's trade with T, and R would thus be put into the hinterland of port S.

Thus it was decided to rephrase the definition of the hinterland as "that region the waterborne trade of which yields, in any given time period, more revenue to one particular port than to any other". Perhaps it would have been more correct to state that the ports were more interested in profit than in revenue, for high revenue jobs also mean high-cost jobs, but with the difficult nature of company finances (especially as regards the ploughing back of profits and the non-profit making characteristic of some ports) it was assumed that the profit varied proportionately to the revenue from port operations.

An important point to be stressed again and further expanded here is that, for a region to be considered as part of a port's hinterland, more has to be shipped through that port than through any other. This is definitely not the same matter as saying that if a port has more trade with or makes more revenue from, one area than any other then that area is in the hinterland of that port. For clarification on this common

mistake consider the results of such a conception concerning the city and port of Ottawa, Ontario. In 1963 its sole trade was the import of 552 tons of structural shapes and sheet piling (7). For the port of Ottawa, it is almost beyond doubt that all its trade was handled for the City of Ottawa -- so as far as the port is concerned, Ottawa lies within its hinterland. But as far as the city itself is concerned it is far more likely to be in the hinterland of Montreal, for all other commodities would have to be shipped in and out of Ottawa by means of a larger port. It may be stated that the city of Ottawa lies in the import hinterland of the port of Ottawa for its sole commodity, but even so it is probable that more comes via Montreal, which in the same year unloaded 18,857 tons of this commodity. (8).

D. Waterborne

The use of the word waterborne in preference to Mill's term seaborne is really a restatement of the belief that there is no difference between the economic function of a canal wharf and a modern world port, and that in the same way there is no difference in the economic function of a supertanker and that of the freighter canoe still used in Northern Canada, where of course the ports so served will still possess hinterlands. Craft that can only navigate rivers, lakes and canals are also included under the term waterborne for most are definitely not seaworthy, never venturing far from safe waters. The definition will also include the great ore and grain carriers of the Great Lakes as they too are not seaworthy. As a theoretical problem it will be difficult to decide whether hovercraft can be classed as waterborne or not (9), but not until they become of much greater importance than they are today will the problem assume any practical importance.

B. Time Period

The normal time period for such studies of port trade and hinterlands is the year, either the calendar year or the financial year, usually as a result of data being collected on a yearly basis. This unit of time is usually taken for it rules out seasonal variations but the point that is to be made here is that it is sometimes just as instructive, if not more so, to study these seasonal fluctuations. For this reason it is essential that the time period under study must be given and adhered to.

In Canada the major interest in seasonality derives from the fact that most of her ports are inactive in the depths of winter and those in the north are open only in midsummer (the average 'season' of navigation at Churchill, Manitoba is 70 days, and at Moosonee, Ontario, 90 days). As a result the pattern of trade movements within Canada varies markedly seasonally, with the result that the hinterlands of ice-free St. John, New Brunswick, and Halifax, Nova Scotia are much extended during the winter season (10). By taking an average of the summer and winter hinterlands of these ports one arrives at an intermediate stage which happens for only a few weeks each year and which is not representative. For the ports that close during the winter, only one hinterland is needed, the winter one is non-existent, but for these ice-free ports adjacent to closed ports, it is essential to show both hinterlands separately.

Other seasonal variations might also prove interesting. One could follow the seasonal movements of the herring off the east coast of Britain and see how it affects the hinterlands of that product through the various ports through the year by tracing the commodity

movements for monthly periods instead of for yearly periods. The seasonal variations in passenger movements could also be mapped in this way, more passengers from Britain travelling via Liverpool to North America in the summer and autumn, and more in winter via Southampton to the Caribbean, the Mediterranean and Africa, thus giving different passenger hinterlands for Liverpool and Southampton at different times. The length of the period under review does not matter -- however a 20 year period would mask many changes, and a 20 day period may overestimate the effect of single ship departures and arrivals.

F. Region

Perhaps the main problem concerned with the definition of the region is to know which size region should be used in the calculation of hinterlands. For example, in defining the hinterland of Toronto, are the various component parts that make up the hinterland to be thought of as provinces, counties or townships, or of towns, electoral districts, polling subdivisions, blocks, or even of individual buildings? It should be clear that the choice can affect the resultant pattern of hinterlands and is therefore very important. The County of York very probably belongs to the hinterland of Toronto, though some parts of towns, some whole towns and even some whole townships may not. The choice of scales for the region has varied. Weigend for example studied the origin and destination of consignments in terms of towns and even individual plants (11) while Morgan divided Germany into seventeen zones and counted each foreign country as one zone (12). No doubt we shall find that the choice of scale will vary with the scale of enquiry as well as of course the availability of the data.

One point on which the author does feel strongly however is that, at least for the purpose of this study, the areal units or regions should cover the whole area and not consist of points such as factories. This is because we, and the ports, are interested as much in the potential hinterland as in the actual hinterland which, in any case, varies constantly with time. A system of points tells us little about intervening opportunities and may also confuse the issue, making a port feel it has potential in an area where it has one customer, notwithstanding the fact that that customer may not be at all representative of the area in which he is situated.

A further complication arising from the use of small areal units, such as townships and smaller, is that there will be the possibility of fragmented non-contiguous hinterlands. Most writings have implicitly believed that hinterlands are contiguous, as indeed it seems at first sight that they ought, but Sargent illustrated (13) quite simply how they could occur, and Green (14) gave us an actual example of a non-contiguous hinterland, although it did refer to urban, not port, hinterlands. It is quite possible that the more sophisticated our analyses and techniques become we shall discover several non-contiguous port hinterlands.

A second problem concerned with the definition of region is to know whether or not to include stretches of water as part of the hinterlands. Thus Seeman (15) considered that, as the hinterland of any port consists of that area which produces a commodity that can be exported economically from that port, then this also includes parts of the open oceans, that are fished from that port. The concept of 'foreland', used by Weigend to denote the overseas ports of origin and destination for a

port's trade, does not appear to apply here for no other port is involved. It thus becomes very difficult to know how best to classify fishing-grounds, as part of a port's hinterland or its foreland. On a practical basis such stretches of water would be very difficult to define statistically and on a theoretical basis it appears more logical to classify such areas as parts of the port's foreland, thus excluding open water from consideration of port hinterlands. This is not altogether a satisfactory solution but the alternative leads to a hinterland for a good on both sides of a single dockside operation, which is even less satisfactory. Similar considerations exist with respect to the operations of dredging and salvage vessels that land their goods on a dockside, of vessels that dump unwanted materials in the sea, of lifeboats, and of pleasure craft that operate from and to only one point.

The final problem is that of how to treat trans-shipments. Studies have generally treated them separately and not known how to include the fact that, say, grain from the prairies is shipped from the Lakehead to Montreal or Baie Comeau, stored in elevators, then sent off to the world in other, larger ships. Is the grain to be counted as in the hinterland of the Lakehead, of Montreal and Baie Comeau, or both? Using the definition that we have produced it would appear that a certain shipment of grain would affect the hinterland of both ports, for it would yield revenue to both ports, but in the second case it is difficult to know whether the location of that grain is still in the prairies or on the dockside of Montreal and Baie Comeau. The answer is an arbitrary decision for there does not appear to be any logical support for either view, possibly due to an incomplete definition of a hinterland, and that

is that the point of origin of goods for the transchipment port is at this second port itself, in its elevators and warehouses. The slight apparent advantage from treating it this way is that we are not always sure that goods are indeed being transhipped. For example we know that in 1963 Montreal received 2,927,847 tons of wheat from the lakes and shipped out 2,448,336 tons to the rest of the world, (16). However, Montreal will also receive wheat by rail, some of which will be shipped out, some of which will be consumed locally. The same is true for the wheat brought in by ship, so that it is sometimes difficult to know how much, if any, of a good has been transhipped.

G. Summary.

The purpose of this chapter has been to define many of the terms which will be used quite frequently, and especially to make sure that the concept of a competitive, economic, non-overlapping hinterland is strongly made. Some of the definitions, notably with respect to the treatment of water regions and the problem of transshipping, are still in need of further clarification, but it is felt that they are sufficiently defined and made clear for the purposes of this study. (17)

Footnotes to Chapter III

(1) H. R. Mill, quoted in L. D. Stamp, ed., A Glossary of Geographical Terms, (London: Longmans, Green, 1961), p. 255.

(2) e.g. see N. M. Shaffer, The Competitive Position of the Port of Durban, Northwestern University Studies in Geography no. 8, (Evanston: Northwestern University, 1965), p. 141, where he distinguishes between the 'umland' and the 'competitive hinterland' by an isoline representing 70% of tonnage moved through any specific port. The difficulty of theoretically defining this boundary without recourse to actual statistics, is apparent.

(3) Dominion Bureau of Statistics (D.B.S.), Shipping Report 1963, (Ottawa: Queen's Printer, 1964), tables 6 and 11.

(4) All these ports are recognized by the D.B.S. op. cit. and the numbers in brackets refer to the approximate length of unwharfed land between them, in miles: Fort William and Port Arthur (1/2); Red Rock and Nipigon (3); Marathon and Heron Bay (4); Britt and Byng Inlet (1/4 by water, 6 by road); Depot Harbour and Parry Sound (5); Port McNicoll and Midland (4); Walkerville and Windsor (1/4); Thorold and St. Catherines (2); Oakville and Clarkson (3); Clarkson and Port Credit (3); and Whitby and Oshawa (4).

(5) e.g. see Gould's subjective decision to classify Cape Coast and Saltpond as one port in P. R. Gould, Transportation in Ghana, Northwestern University Studies in Geography no. 5, (Evanston: Northwestern University, 1961), p. 18.

(6) A. J. Sargent, Seaports and Hinterlands, (London: Black, 1938), p. 8.

(7) Unpublished material from the D.B.S.

(8) D.B.S., Shipping Report 1963, tables 6 and 11.

(9) When goods are transported from port to port by hovercraft, it is obviously behaving in a similar fashion to waterborne craft. When it travels from one land point to another, it will probably travel on tracks like a railroad, but may well have the versatility of a truck. If this land to land journey encompasses a stretch of water, then the craft resembles most an aircraft. The major difficulty occurs when it leaves a sea-port, travels by water, and then on land discharging at a land terminal. Similar problems are presented by amphibious vehicles and sea/land planes.

(10) e.g. see M. Matheson, "The hinterlands of Saint John", Geographical Bulletin, VII (1955), 65-102.

(11) G. G. Weigend, "Bordeaux, an example of changing port functions", Geographical Review, XLV (1955), p. 234.

(12) F. W. Morgan, "The pre-war hinterlands of the German North Sea Ports", Transactions of the Institute of British Geographers, XIV (1958), p. 48.

(13) Sargent, op. cit., p. 12.

(14) F. H. W. Green, "Urban hinterlands in England and Wales ...", Geographical Journal, CXVI (1950), 64-83. See reference to Spennymoor, p. 81.

(15) A. E. Seeman, "Seattle as a port city", Economic Geography, XI (1935), 20-32.

(16) D.B.S. op. cit., tables 6 and 11.

(17) The distinction between port hinterlands and urban hinterlands (or umlands) is brought out most clearly by L. D. Stamp (op. cit., p. 235). Generally speaking, not much difference is seen between the nature of these two types of hinterland. One can imagine an urban hinterland of a seaport comprising the areas served by that town's shops and services. The port hinterland of that town is merely a hinterland depending upon the specialised service of that town as a port and it can thus be regarded as merely a component part of the total urban hinterland of that town in the same way that a single-commodity port hinterland is a component part of the total port hinterland.

CHAPTER IV

FACTORS THAT AFFECT THE SIZE AND SHAPE OF HINTERLANDS

A. Introduction

Now that it is clearly understood what constitutes a hinterland, we can proceed to analyse those factors which delimit its shape and size. It should be remembered that this will be tackled on a theoretical basis and not on an empirical basis because the aim of this thesis is not so much to understand the nature of any one particular hinterland as to try and understand the nature of hinterlands in general. The collection of data pertinent to actual hinterlands is a long and tedious occupation -- even more so in that it is difficult to really be sure which facts are pertinent without the backing of a theoretical basis. However, if a model can be constructed which will approximate closely to reality every time then it will be a much simpler process for succeeding hinterland studies to merely fit the relevant facts into the model and be presented with a reasonably accurate map of thehinterlands required, be they past, present, or future.

The belief that such a theory is required was strengthened by the circumstances attendant on the opening of the St. Lawrence Seaway: many people, amateurs and professionals, tried to gauge the effects this would have on the port activity and hinterlands of the various ports, notably Montreal. The conclusions ranged from the complete closure of Montreal as a world port to a belief that the port would experience a

surge in world trade, both expressed as a result of the opening of the Seaway. It is very unfortunate if we have no way of being able to measure such effects, catastrophic as they could have been, and it is hoped that in some way this model developed here will be capable of being predictive as well as descriptive and explanatory.

To enable us to form such a model, however, that would be applicable outside of the North American continent and the twentieth century as well, we really require theories that are of universal application and are unchanged little from time to time or from place to place: there is no real reason why the eighteenth century hinterland of Zanzibar should differ from that of New York today, except in its size and shape. This means, however, that we shall have to start with very basic assumptions concerning human behaviour and add to them as much as possible. We need to remind ourselves here that a hinterland is not a discrete, observable phenomenon, but merely a result, statistically determined, of the summation of human decisions concerning the transportation of goods through ports, so that what we really need to study is the individual decision to ship goods by a specific route through specific ports.

Perhaps it is too obvious to need stating here, but the major determinant of all such decisions must surely be cost. Both a buyer and a seller will aim to ship goods between them at the lowest possible total cost, for all transport is a waste of time and money. There will of course be exceptions to every rule and the U.S.S.R. provided such an exception in the years 1917-57 when what little external trade she had was passed through ports chosen more for socio-political and strategic reasons than for cheapness. Even this exception, however, was removed when the Soviet Union

decided to economise and urged economic routings of shipments.

Many of the early studies of the location of industry took only cost as the dominant factor in their models, attempting to explain distributions and locations by reference only to the costs of procuring raw materials and selling their product. These studies showed that this one factor was insufficient to explain most locations and it may be thought that it will be similarly insufficient in describing the routeings of shipments. However, three main reasons support the view that it will be sufficient or, at least, will account much more for routeing decisions than it does for location decisions.

In the first place, when a manufacturer locates a new plant it is a single decision which may quite possibly be tainted with secondary considerations such as the climate, or the social life or even historical chance, all tending to subjugate the importance of cost as a deciding factor. When, however, this same manufacturer begins to import new materials and export finished products he will not concern himself that one port is uglier than another, or that its inhabitants speak a different language, or that the trucking route passes through pleasant countryside. As far as he is concerned he just desires to receive his imports as cheaply as possible and to be able to deliver his goods to the customer as cheaply as possible.

A second reason for the insufficiency of costs alone to explain industrial locations is that often, through ignorance or poor weighting factors, the businessman may select a poor location. Somehow or other that location has to be 'explained'. Again, matters are different when it comes to the transport of goods. Admittedly the first few consignments

from a factory may not have travelled over the most economic, that is to say cheapest, route, but every week, every day, the manufacturer is at liberty to experiment, by trying out new routes. By a system of trial and error, a system which is too costly a way of arriving at the best location for a factory, he can and does arrive at the cheapest transportation routes for his products.

A third reason for expecting better results is that all the decisions concerning transport routes at any one time were made not long before the actual movement of goods -- any firm that fails to react to a changing cost structure will soon experience declining profits -- whereas the decisions concerning factory locations in any one area were made at different times, and no doubt reflect different circumstances. As a result the location of industries is very hard to comprehend without a detailed background of the cost structure at various times. This is not necessary when studying routeing decisions because the majority, if not all, of these decisions were made against the same backcloth of cost structure.

The study now proceeds and views the various components of cost believed to be responsible for the routeing of goods and shows -- against a backcloth of a hypothetical study area -- how they can affect the size and shape of a port hinterland. There are held to be four major costs -- of transporting, of handling, of time, and of insurance -- and three other costs that are indeterminate in importance, the costs of bulk economies and indirect economies, and costs due to the human factor.

B. The Study Area.

The study area, depicted in Figure 1, is a rectangular area, 200 miles from west to east and 100 miles from north to south. It is bounded on the south by a body of water and on the other three sides by political boundaries whose nature does not permit the passage of goods across them. By adding the further simplifying assumption that there are no facilities for transport by air, it is seen that all imports and exports of this political unit have to enter or leave by its seaports.

Along the coastline are eight ports, A to H, which handle all of this external trade and whose locations were randomly selected. One hundred possible locations were given, at an even distance interval of two miles, and were equally weighted: the first eight numbers drawn gave the port locations. There is no special importance attached to the number eight, but it was believed that it would prove a convenient number to handle.

It is assumed that each part of this study area is capable of importing or exporting goods through all of the eight ports and the model which results from a study of the factors involved will purport to show through which port any one consignment, and therefore all consignments, will be routed.

The method by which these factors will be severally studied is one of isolation, by holding constant all other factors, and allowing the effects of the one factor under study to vary, noting the results on the size and shape of the hinterlands of these eight ports.

C. The Factor of Transport Costs.

It is generally assumed that the costs, or freight rates, charged by transport carriers vary directly with distance. This does not mean

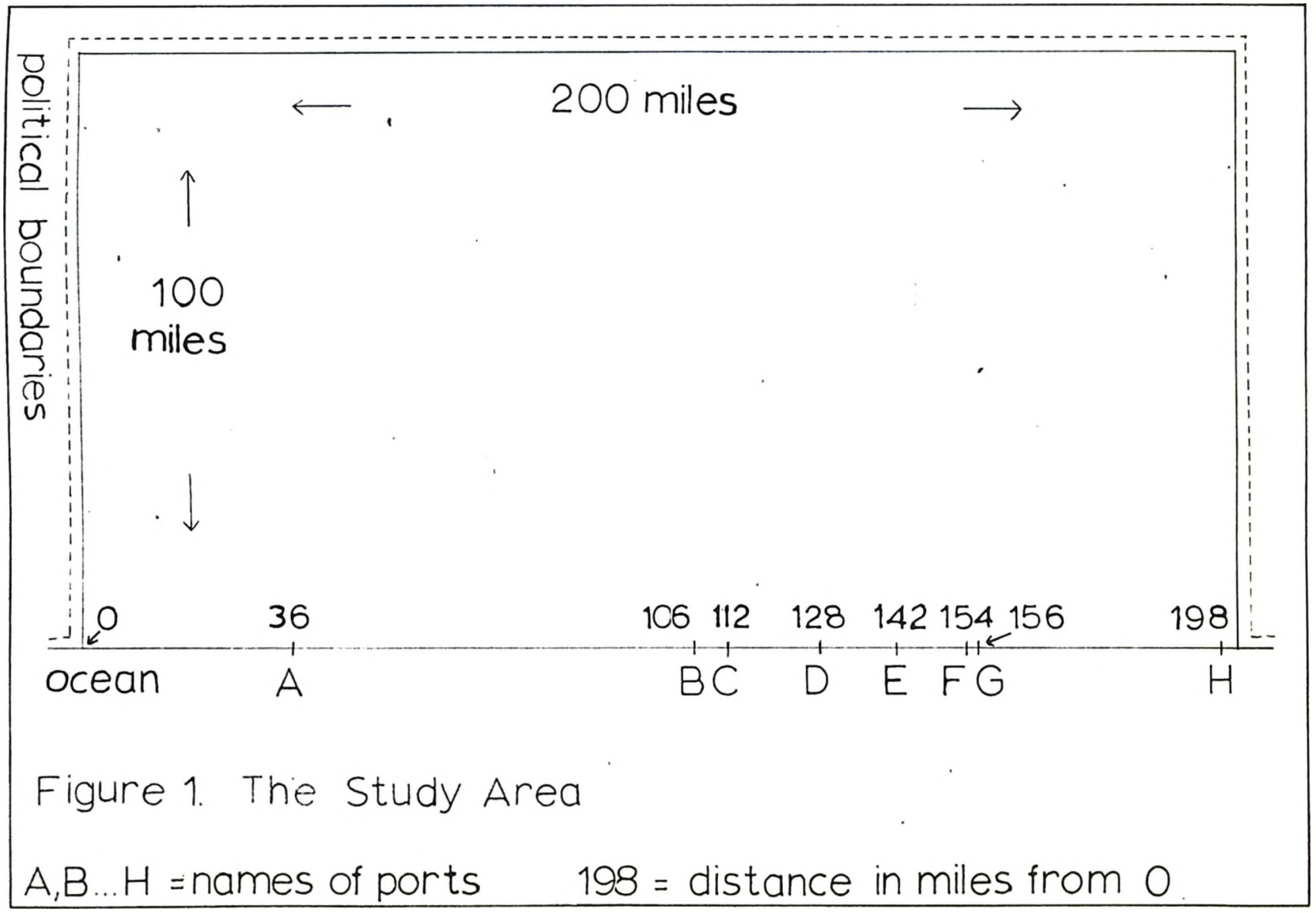

Figure 1. The Study Area

A,B...H = names of ports 198 = distance in miles from 0

that they should necessarily rise on a one to one ratio with distance but that, as distance increases, so will the price paid for transporting the same commodity. The rate at which such charges rise varies with the different classes of carriers and also with the individual companies, but normally speaking they can be expressed by a simple equation such as $F = A + fBC$ where F is the final charge; A is a fixed sum representing terminal costs and an indeterminate percentage of the overheads; B represents the cost per mile; and C the number of miles. As B is not composed solely of actual carrying costs but also bears part of the overheads its actual value may tend to vary according to the size of C (the rate per mile usually decreases as distance increases) and so a function f is inserted. Carriers that offer a low A cost but a correspondingly increased B cost are usually most competitive over short distances, while those with a relatively high A value or intercept are usually able to secure long-distance traffic. Trucking is the normal example quoted for the former and barges for the latter.

~~Although~~ In this section we will assume that this equation varies with the mode of carriage but that all companies in any one form of transport will have identical rates. This assumption does not conform to present-day conditions, but it simplifies the problem and enables us to observe the effects of the factor of distance upon the size and shape of the hinterland.

(i) Land transport costs.

If for the moment we hold all other costs constant -- that is to say that there is no charge for shipping, all port charges are identical, and all other costs are assumed nil -- then the only costs that will vary

will be those pertaining to the movement of goods on land: thus if we assume that the shipper continually seeks to minimise his costs then the only way in which this is attainable is by a reduction of land transport costs. This means that he will ship through the nearest port.

In Figure 2 the effects of this upon the shape and size of hinterlands can be seen when we take 'distance' to mean 'straight-line distance'. By shipping through the nearest port -- nearest by means of a straight line -- a completely regular pattern of hinterlands emerges, the boundaries of which are perpendicular at the mid-point of lines connecting adjacent ports. Note that those boundaries, though necessarily straight, are parallel solely as a result of the straight coastline. Another important point to notice is that the port itself need not be symmetrically placed with respect to its 'natural' hinterland (1).

However, freight rates, even if proportional to distance, will not necessarily be proportional to the distance that the crow flies, but more likely to the distance that the transport medium actually covers. That is to say, a railway company is more likely to charge its rates according to the length of track between any two points than to the straight-line distance between them, while a trucking company is presumed to base its rates on the road distance covered. Thus we have to take account of the actual transportation network and in Figure 3 are shown the effects of two uniform road patterns or networks -- on the left a grid system of roads spaced at a regular distance of about 4.1 miles and on the right a grid system built at a regular distance of 16.5 miles. It should be noticed that the closer network of the left portion yields hinterland boundaries very similar to those of Figure 2, but that in the right

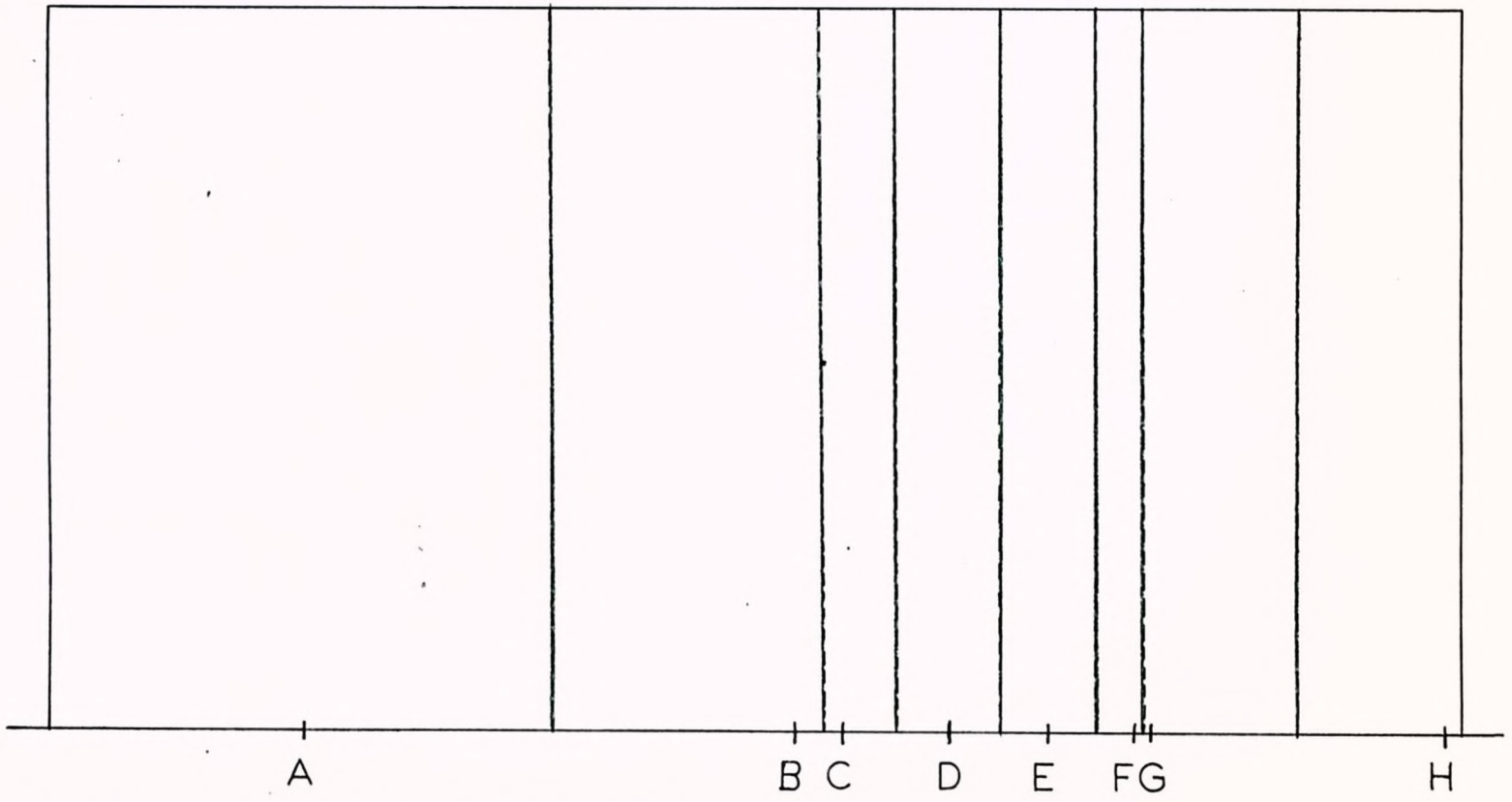

Figure 2. Hinterlands as Determined by Straight-Line Distances

----- =hinterland boundaries

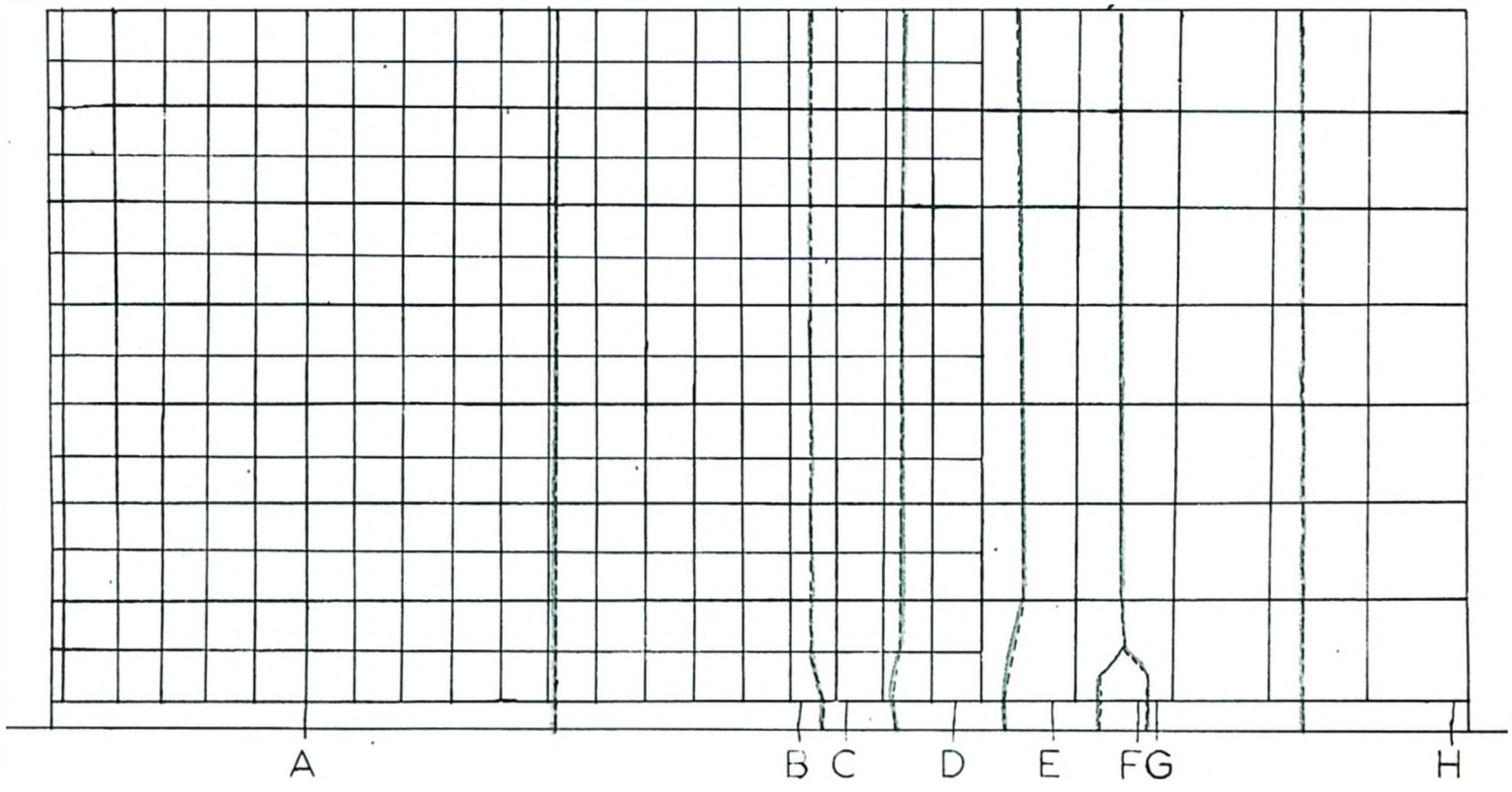

Figure 3. The Effects of a Fine-grained (Left) and a Coarse-grained (Right) Grid System of Roads upon the Size and Shape of Hinterlands

---- = hinterland boundaries ✕ = roads

portion the hinterland of port F has all but been erased as a result of E and G being closer to the two vital arteries into the interior. The important point to notice is that this is mainly the result in differences in coarseness or texture of the two systems. The more fine-grained a rail or road network is, the more will port hinterlands resemble the 'natural' hinterlands of Figure 2, while the coarser they become, aggrandisement of hinterlands by ports at the expense of each other becomes more prevalent.

Progressing from the use of theoretical road patterns, let us examine the effect on the size and shape of hinterlands by using an actual existing road pattern, that of the Southern shore of Lake Erie in 1950 (2), and fitting it into the study area, in Figure 4. The irregularity of the road pattern should lead us to expect an irregular pattern of hinterlands, these being still based upon shortest road distances, and the map bears out this belief. The hinterlands of Ports C and E are almost negligible while that of G is greatly diminished. Of most note is the enlarged hinterland of port D which includes parts of the 'natural' hinterlands of all ports except A and H. This is due mainly to the convergence of three roads in the immediate vicinity of D. It should be stressed that even slight realignments of some roads could cause major changes in the observed pattern of hinterlands.

The relatively fine-grained network of the road system has altered the 'natural' hinterlands substantially but railway systems are usually much coarser and will thus lead to further disruption. Figure 5 shows the railway network for exactly the same area (3) but the hinterlands, based on the shortest trackage distance, are greatly different to those observed in the preceding map. All distances are measured from stations

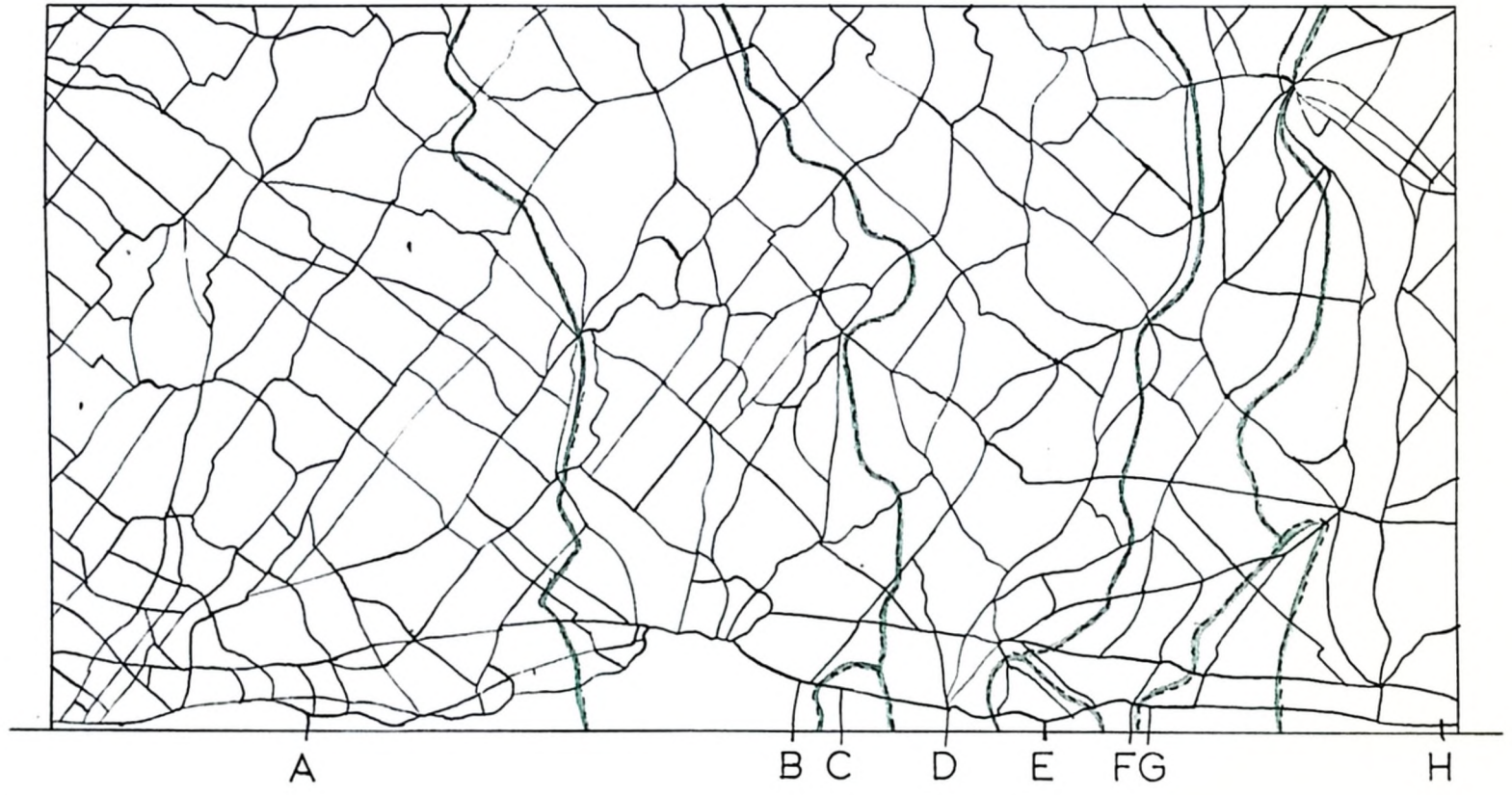

Figure 4. The Effects of a Normal, Unpatterned Network of Roads upon the Size and Shape of Port Hinterlands

—— =hinterland boundaries ⟩⟨ =roads

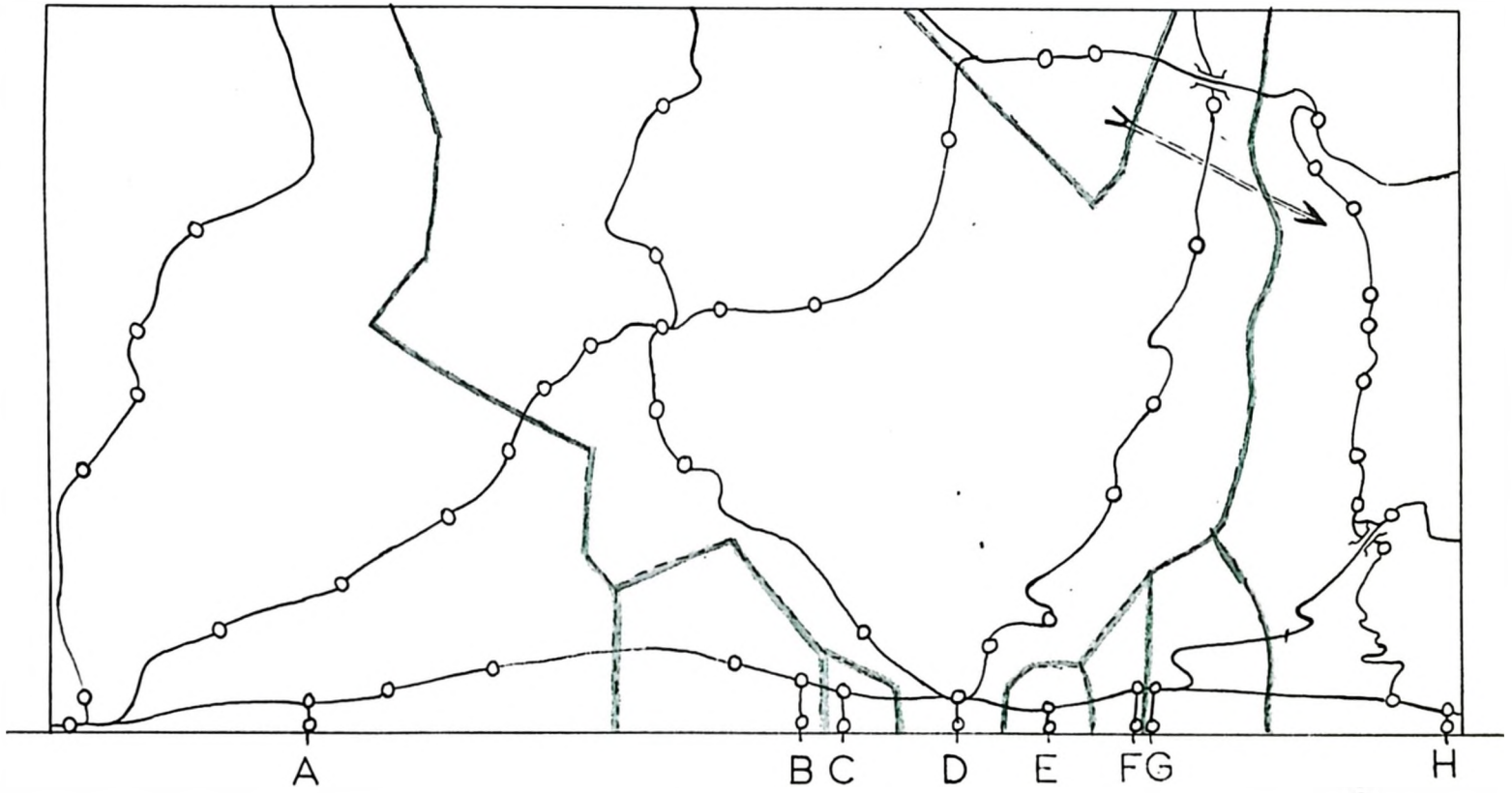

Figure 5. The Effects of a Normal, Unpatterned Network of Railways and Stations Upon the Size and Shape of Port Hinterlands.

—— = hinterland boundaries —o— = railways, station, and bridge.

and trains can run from one line to another only if a connecting link is shown. The unusual arrangement of hinterlands in the upper right portion of the map is a result of two railway lines which cross without any transference facilities, thus showing how easy it is to obtain non-contiguous hinterlands, using merely the factor of shortest distance. Once again, the hinterland of D has enlarged at the expense of its neighbours, again due to radiating transport links.

So far we have stressed the importance of distance as the controlling factor in land transport costs but it is an acknowledged fact that there are many other factors that help determine the final freight rate, and these were discussed in Chapter II. Some of these factors are 'geographical' in the true sense -- the effect of mountain barriers and marshes upon the networks of land communications is not disputed -- and others could be classed as political, economic and human. These factors either affect the pattern of communications or, more normally, they affect the pattern of freight rates. This thesis does not dispute the importance of these many factors upon the final freight rate pattern and therefore the size and shape of hinterlands, but it claims that hinterlands can be satisfactorily studied without more than a passing reference to them. The important point is that, in minimising his land transport costs, a shipper will take notice only of the existing freight rate pattern. He may well be interested to know why that actual pattern of rates is as it is -- and it is a legitimate study in geography to observe the various factors that make up freight rates -- but it is the rates themselves that affect the shippers' decisions, not the factors, not even distance itself.

Nevertheless, mention should be made here of the major factors that do affect rates. We have noticed that they tend to vary positively with distance, and they will always increase as the weight of the consignment increases. In addition, rates tend to increase with the value of the good and also if the good is 'inconvenient' -- dirty, dangerous, and high volume goods tend to pay more. Rates also tend to be lower per ton/mile when they involve large cities than when they are between two small places, again due to the increased inconvenience to the authorities, usually in having to use equipment inefficiently.

For all these reasons it becomes obvious that the distance approach is not the only one, nor even the best one. The only useful criterion in drawing up land hinterlands (i.e. without reference to varying forelands) would be that an internal place would ship to that port for which it is charged the lowest overall rate -- the analysis is thus statistical rather than cartographical, although of course the resultant determined hinterlands will be capable of being delimited on a map.

(ii) Marine transport costs.

Land transport costs constitute only one side of the total transport costs -- just as important are the costs of transport between any two ports. To be able to study the effect of them in isolation it is necessary again to hold all other factors constant: thus it is now assumed that no costs are involved in the movement of goods from any part of the study area to any of the ports, and no other costs are encountered.

Let us now assume, as in the preceding section, that the costs of transport vary directly with distance, and that all shipping routes are straight lines. If we consider a destination port to the west of the

study area, the distance from that port to port A will be less than to any of the others, therefore the cost is less, and therefore the whole of the study area lies in the hinterland of port A. Similarly if there was a port to the east of the area, port H would handle all the trade. If a port to the south is considered, so distant as to make the distance from it to all eight ports almost identical, then shippers will be indifferent as to which port to use -- being offered the same rates from all -- and smaller, less significant facts will tend to dominate the routeing decisions.

However, as we have just seen with reference to land transport, the actual freight rates are not solely dependent upon distance, but also upon such factors as politics, competition, shipping line policies, the incidence of ice or shallow water, and even the nature of the vessel. It is almost impossible to predict accurately the effect of each of these factors upon the final freight rate to the public, but it is a comparatively simple task to garner these various rates and see which one offers the cheapest service to any given destination, and which would then control the whole of the hinterland.

(iii) Total transport costs.

Needless to say, neither land transport costs nor marine transport costs operate to the exclusion of the other and what is taken into account by the shipper is of course the combined costs of the two. Let us take a hypothetical trade movement from point S, in the north-western section of the study area, to Port K, a foreign port lying to the east of the area (Fig. 6). We have already seen that, if marine transport costs are nil, S would ship through, and be in the hinterland of Port A; whereas if land transport costs were zero, it would ship through port H. Now, of course,

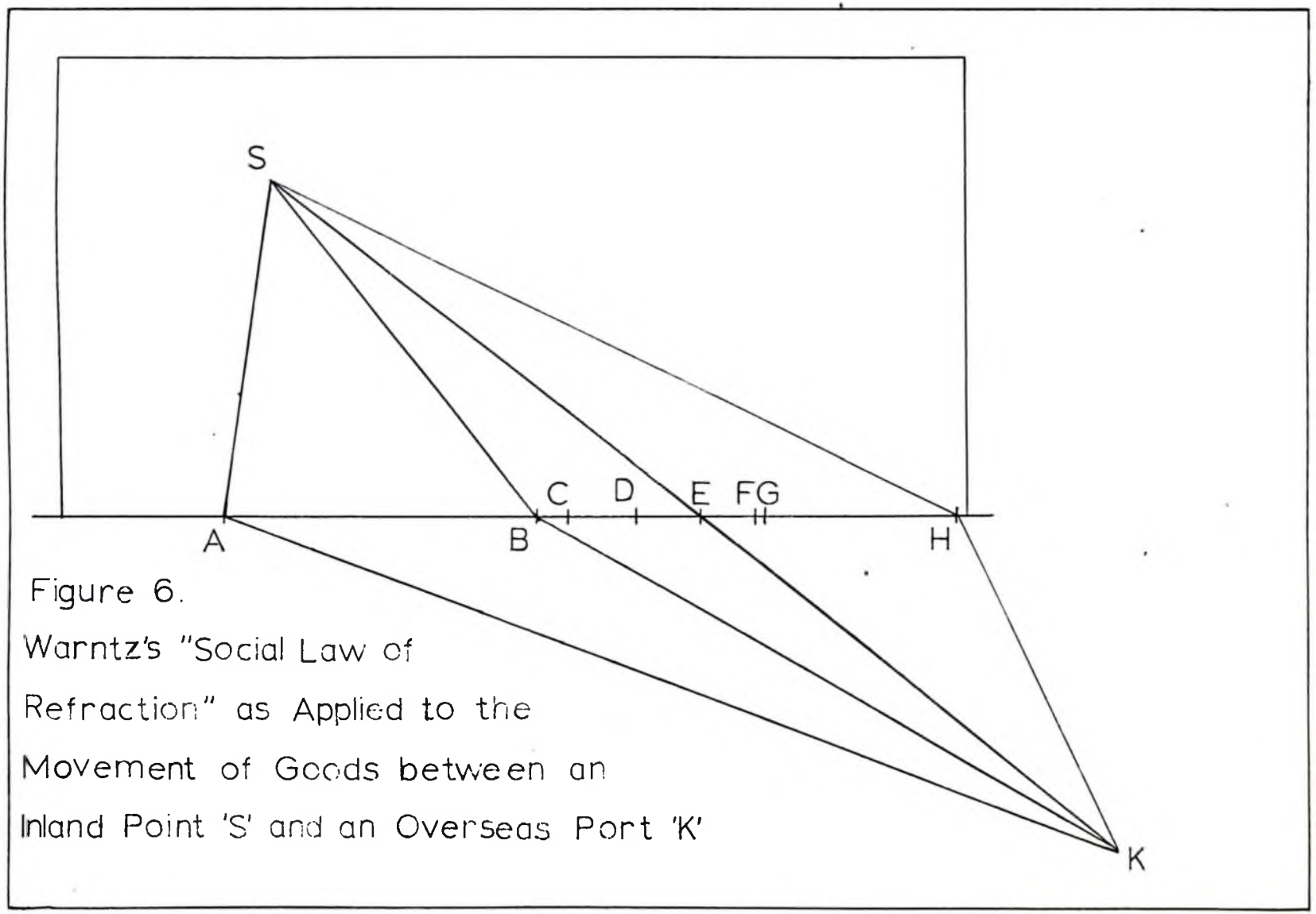

Figure 6.

Warntz's "Social Law of Refraction" as Applied to the Movement of Goods between an Inland Point 'S' and an Overseas Port 'K'

such conditions rarely, if ever, obtain, and we must study what happens when both forms of transport have positive costs.

Warntz (4) argued that it would depend upon the relative freight costs per mile of the two carriers. If the land rates were excessively high compared to marine rates, the cheapest total would no doubt be obtained by shipping through port A. Similarly, if marine rates were so high that shippers would do anything to cut the marine distance to a minimum, then shipments would be routed through port H. If equal rates were offered by both carriers then the goods would attempt to travel in a straight line between S and K. Warntz stated that this was very similar to the natural law of refraction -- light rays passing from one medium to another being deflected if one is denser than the other. Similarly, he argued, goods travelling from a less dense (cheaper) cost medium to a denser (more expensive) cost medium would tend to be refracted, the angle of the line at the coast being greater in the denser medium. For example, if we assume that marine freight rates are the cheaper (less dense), the most direct route from K to S for a beam of light and a shipload of goods would be via port B, the angle CBK being smaller than the angle ABS.

This analogy is extremely useful in helping us to understand why some goods tend to minimise the land journey and others minimise the sea journey, though, as will be demonstrated in section E, it is not the only factor involved. The analogy is not the social scientific law that Warntz would have us believe, however; for one point, it could not explain the reversed direction of the trade at the coastline evidenced by angle SAK, nor could it if a line was drawn to S perpendicularly from the coast; and again, it would not allow of movements almost parallel to the coast --

the law of refraction works with two substances of widely varying density (expense) only up to the critical angle of 49° either side of the norm. After that the law of reflection takes over, and this would not permit a ship to discharge goods for the interior if it approached the coastline at an angle (such as KAB, KBC) of less than 41°. This of course happens in practice.

Putting it back in terms of total cost, all one would have to do to decide through which port such a shipment would move is to sum up the total costs of moving through each port, the commodity being shipped through that port which offered the lowest total transport costs. However, as was mentioned earlier, transport costs are not the only costs involved, and the study of the additional costs follows.

D. The Factor of Handling Costs.

In addition to paying the actual cost of transporting goods by way of freight charges, a shipper will need to pay for the handling of these goods. 'Handling' includes the loading and unloading of goods on and off all forms of transport and may also encompass storage and warehousing expenses. Normally they may be thought of as fixed costs, for the costs of loading and unloading do not usually vary with the distance that the goods travel.

A high percentage of these costs can be discounted, however, as much of this loading and unloading is performed by the carriers themselves and the payments for such services are allowed for in the overall freight rate charged by these carriers. The effects of the freight rate -- and thereby also of those handling costs included in them -- has already been studied in the preceding section.

The remainder of the handling charges are usually to be found within the port confines and are carried out by various bodies -- usually the harbour authorities and independent stevedores. How much of the movement of goods in a port system depends on these groups and how much upon the various carriers will vary from port to port, but normally the port firms will undertake to move goods into a warehouse from a rail siding or a truck terminal and to load them directly into the hold of the ship. It is important however to notice to whom they send the charge -- in some ports stevedores are paid for by the shipping line and in others by the owner of the goods. Eventually it does not matter to the shipper for he will have the same total charges to pay. However, those ports that charge the shipping line and the other carriers with most of the handling costs appear in an unfavourable cost light until the fact is taken into consideration that the shipper has very little extra costs to pay. Similarly, a port that makes out most of its charges to the shipper will appear at first sight to be in a good competitive position, for the carriers' freight rates will correspondingly diminish, although the total handling costs may be the same as in the first port.

Schaffer (5) studied the port charges of the South African ports and came to the conclusion that the charges made to the owners or shippers were very similar and therefore could be discounted as an important variable and classed as a constant. This may not hold true for all areas however, and the facts would need to be collected before they could be so dismissed. Even so, they may still form a significant percentage of total shipping costs and should therefore be considered as an important cost.

An interesting feature of port costs is that they may vary from time to time. Thus if a good has a seasonal variation in flow, the cost of moving it through a port may well be more in the peak season than in the off season. This will partly be an attempt to increase profits on the part of the port authorities, but it may also be the result of port constraints. There are several types of constraints -- they may be physical, due to the inability of the port to handle certain commodities, or vessels greater than a given size, or they may be human in nature, where the port's fullest development is hampered by an inefficient port authority, or where an agreement is made between a group of ports to share the trade and specialise in certain commodities or destinations.

A third kind of constraint is in evidence and this may be thought of as a short-term constraint, where a port may be able to handle all of its local trade for most of the year but is unable to handle all the peak season consignments. This may result in goods being routed through otherwise uneconomic ports where port charges and other costs are higher, these ports dealing with this commodity only at the times of peak flow. This, however, can all be viewed as a result of the cost of time. If the exporters were not in a hurry to despatch their goods they could wait for the usual port to clear itself and accept more goods again. In a sense they are paying extra charges to compensate for their goods being shipped more speedily. This is discussed in more detail in the succeeding section.

E. The Factor of Time.

The review of the geographic literature on hinterlands in Chapter II showed us that many students of the subject believe that time is an effective factor in routeing decisions. However, none suggested how we could measure the cost of time and so, in this section, we shall show firstly how time can be measured, and secondly a method by which this time can be translated into cost. The resultant costs ought enable us to understand how important the factor of time is.

(i) The measurement of time.

The two major aspects of time to be reckoned with are, firstly, the amount of time consumed in the actual transporting of the goods, and, secondly, the amount of time spent in storage due to infrequency of departure times.

Measuring actual time taken to move goods is rarely a problem. For movement by train, aircraft and coach, schedules can be obtained from which the actual journey time is soon deduced. Ship departures are usually well-publicised but, unless it is a relatively short haul, arrival times are not and this renders it more difficult to obtain an estimate of the time involved in each journey. Ship speeds naturally vary and therefore so would the time involved for any specific journey. The only solution appears to be an average composed of all observed time values for any specific journey.

Measuring the time taken by road vehicles is a more difficult task, however, as they do not run to any fixed schedules normally, merely completing each task in the minimum of time. One way of handling this is to assess the capacity of each stretch of road in terms of miles per hour.

This was attempted in Figure 7 where the same road pattern is shown as in Figure 4 but with each section of road classified according to the data on the topographical sheet (6). Each class of road was then assessed as having a certain capacity for trucks in terms of miles per hour. These assessments were based on speed restrictions on similar roads in Ontario, observation, and the use of express coach schedules. Resulting from this it is believed that a truck could maintain an average of 50 m.p.h. on a three or more lane highway, and 40 m.p.h. on a two-lane highway, both of heavy duty nature. On a medium duty road of two lanes it was felt that 30 m.p.h. was a realistic figure while 20 m.p.h. was given for all roads without a proper surface. Only the larger urban centres are classed as such on the map and it was decided to put the average speed here at 10 m.p.h.

The various inland points were then classed as being in the hinterland of that port to which they are nearest in terms of minutes, this being achieved by multiplying the mileage of each stretch of road by the number of minutes taken to cover one mile on that class of road. Direct comparison between Figures 4 and 7 should be made to see the differences that can result in the size and shape of hinterlands, depending upon whether the criterion of 'nearest' is measured in miles or minutes. The most significant feature of Figure 7 is the remarkable diminution in size of the hinterland of port D as a result of the congestion experienced in the port city itself, leading to the expansion of the hinterlands of B, F, and, to a smaller extent, E. It is a factor such as this that helps to explain Port Credit's success as a general cargo port, it being much more accessible to parts of Toronto than the port of Toronto itself due to the

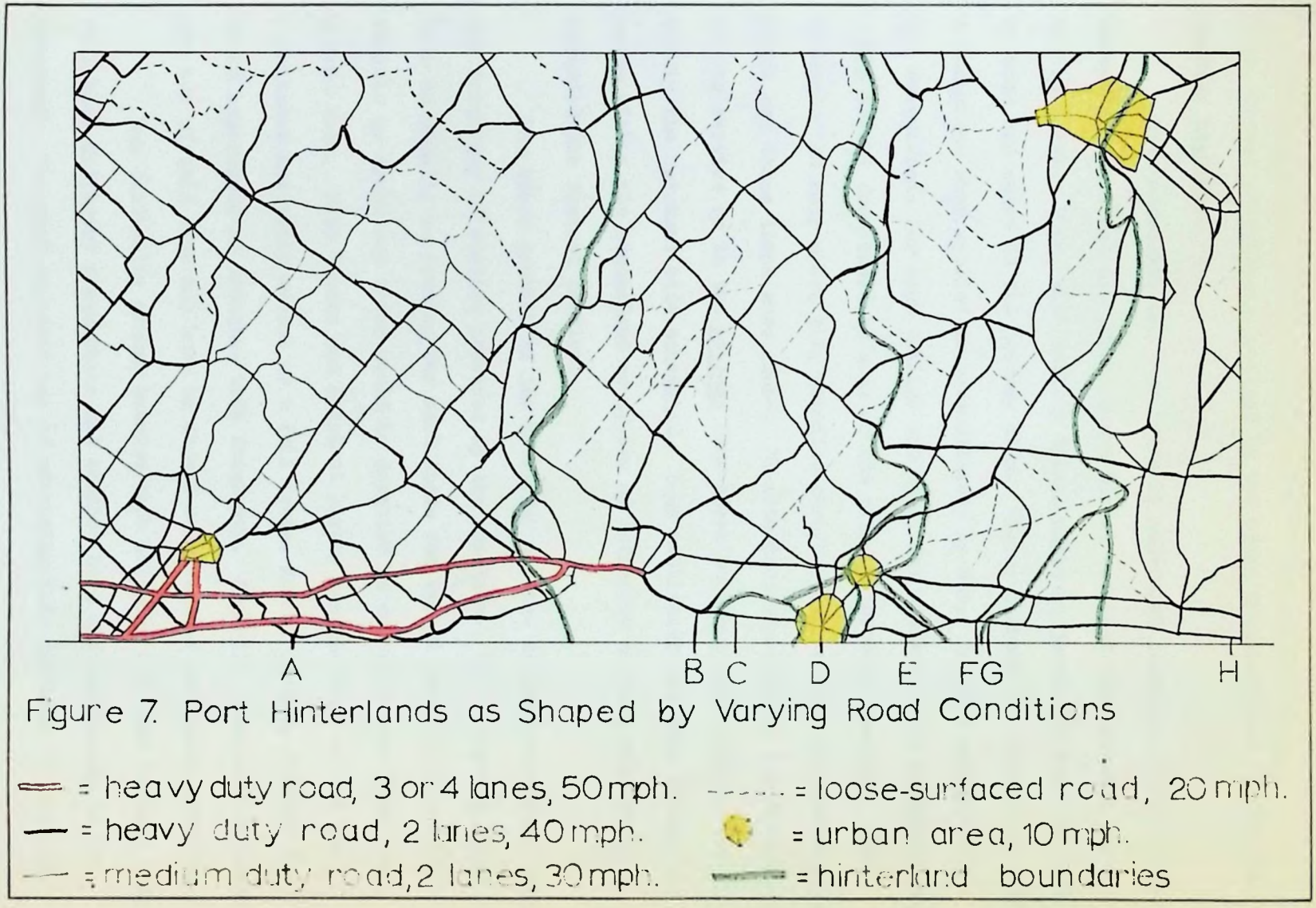

Figure 7. Port Hinterlands as Shaped by Varying Road Conditions

fast, direct connections provided by the Queen Elizabeth and MacDonald-Cartier highways.

When measuring the time taken by scheduled carriers, it must be remembered that not all journeys are direct but that some require changing vehicles. Thus, with railway times, waits at junctions must be kept in mind and added to the journey time. Figure 8 shows the result of such a technique when applied to accessibility by bus. In this example, it was calculated, for each village and town, the quickest time in which one could travel from there to each of the cities (Toronto, Hamilton, and London). In many cases this entailed changing and waiting for connecting links and these times were added. No attention was paid to the frequency of the service or to the average time taken to reach each centre, but merely the quickest time scheduled. Each settlement was then classed as being within the hinterland or sphere of influence of that city which recorded the fastest service.

The other problem of the measuring of time is that concerned with the frequency of service provided by the carriers. With trucking firms this is usually no problem for most loads for export would fill a unit vehicle or truck and these would be supplied as and when each firm required them. With trains and ships it rarely happens that a firm can commission one whole vessel or a full train, but if it did, then it too would experience no troubles with frequency. Normally, however, shipments are not of this size and have to depend upon regular scheduled services.

The difficulty arises because each shipping lane and railway line will have different frequencies and somehow this difference has to be measured. The most apparent way of measuring this in terms of time is

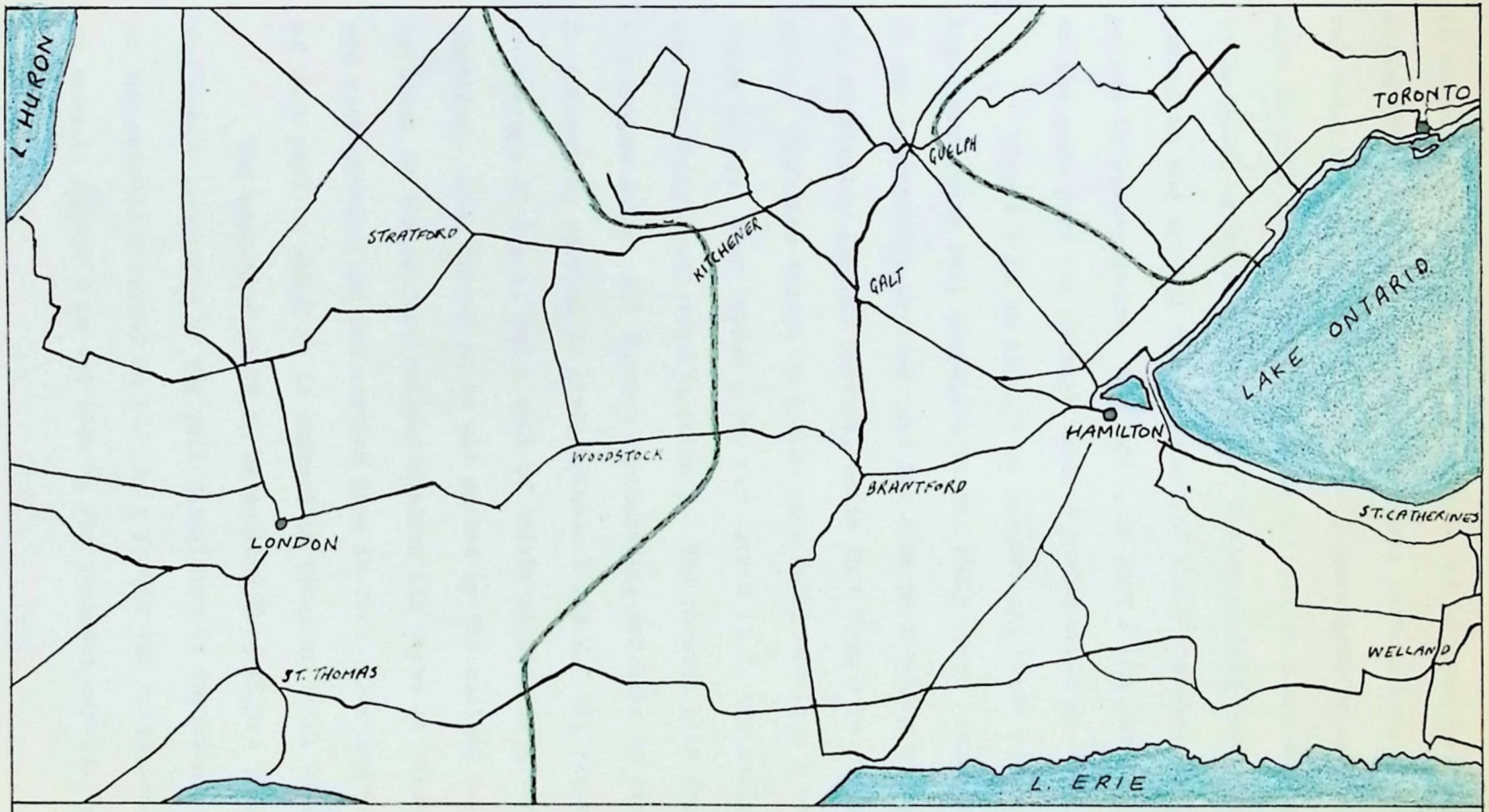

Figure 8. Urban Hinterlands of Toronto, Hamilton, and London as Derived from Bus Schedules for June 1965

⟋ = bus routes —— = hinterland boundaries

to measure the average waiting period: if we consider that port A has seven ships a week to a certain overseas destination, the average interval between departures is 24 hours. A consignor or consignee will thus have to wait for any length of time between 24 hours and no time at all to despatch or receive his goods. Presuming that production cannot be geared to the arrival and departure of these vessels, the average waiting period is twelve hours. Similarly, if port B had two vessels per week to the same port the average waiting period would be 42 hours.

Figure 9 is an attempt to measure all these various facets of time concerning rail transport in the study area. Concerning frequencies it was arbitrarily decided that the line penetrating north-east from D has no regular freight service, while that from D to junction T runs daily. The line from G to Z also runs daily and from H to junction V twice daily. Four trains a day run from W to V, two daily from W to X, and two daily north from junction T. The coastal line from W to H has six trains daily, all figures representing services in each direction. No connecting service is given between Y and Z. All trains are presumed to average 20 m.p.h. and a wait of thirty minutes is given for each junction. Each inland point not served by the railway is assumed to ship by truck to the nearest railway station (in terms of straight-line miles) and each station and its service area is then allocated to the hinterland of that port to which it is nearest in terms of total time.

The important point to be noticed from Figure 9 is that, although the actual existence of the rail facilities is important, just as important is the service provided on it. As a result the extensive hinterland of D as seen in Figure 5 is cut into by the frequent service form W to V which

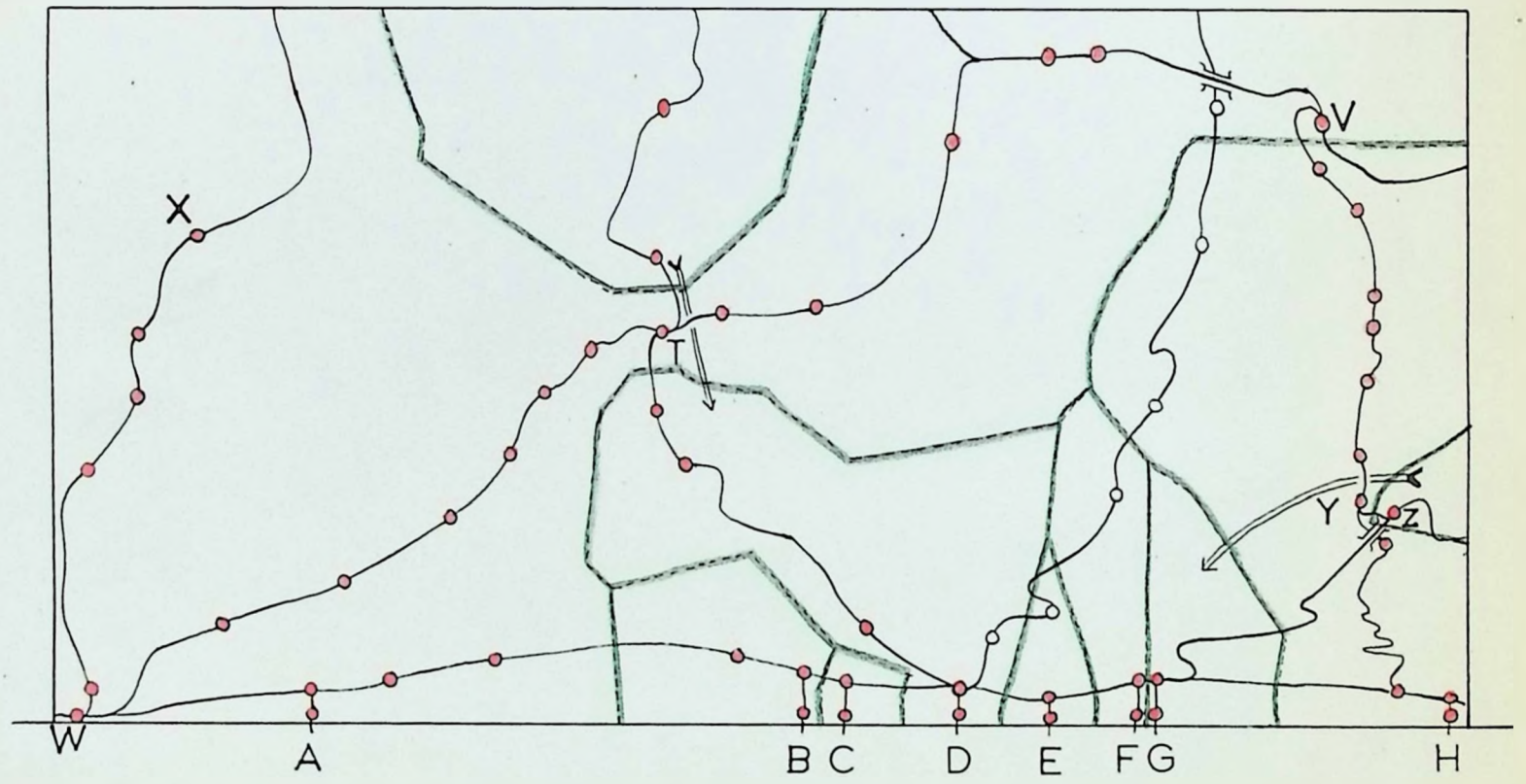

Figure 9. Port Hinterlands Derived from Train Frequencies and Speeds

benefits A. Junction T provides a difficulty however: for freight from V to T there are four trains a day, one of which connects with the daily train to D. Goods on this train would presumably travel to D because it is quicker than continuing to A, but goods on the other three trains would proceed to A, shipping 75% of the goods through A and 25% through D. (This is also attested to by the average waits of three hours at V for a train to A, and twelve hours for a train to D). However, consider the line that runs into T from the north: this has two trains a day, both of which connect with a service to W and A, but one of which also connects with the train to D. Again, goods on the second train will no doubt travel to D, and on the first to Port A. Thus presumably 50% of the trade will travel to each port. However, the waiting-period for A is only six hours as opposed to twelve hours for D, which would suggest that the majority of the trade would pass through A; whereas the equal waiting-period and the shorter route to D would suggest that D would receive at least 50% of the trade. A modification to the measurement of time had to be brought in as a result and that is that any one train could only be counted upon as serving one port (unless two or more ports were identical in terms of time-distance), thus placing stations north of T in the hinterland of D while T itself is in the hinterland of A. (This is because the waiting-period for both ports is now twelve hours and the distance to D shorter than that to A.)

(ii) <u>The translation of time into cost</u>.

We have now seen how, by using either freight transport cost or time as a criterion, shippers may route their goods several ways. Very rarely, if at all, do they use only one of these as the criterion by

which they decide, most taking time and freight rates into consideration. Nevertheless, the importance of each appears to vary from good to good, some goods behaving as though time were the only cost and some as if time had no cost at all.

Those goods that tend to emphasise the cost of time are generally termed 'perishables' though this term extends beyond fruit, meat, and flowers to include such commodities as mail, news despatches and businessmen; goods or services which rapidly depreciate if not delivered on time. By travelling faster, the visible (or transport) costs increase, but presumably the cost of the time saved by such a routeing outweighs this, otherwise a cheaper, slower route would have been taken. Other goods that travel quickly are high cost goods: a much observed phenomenon, but little-explained. Equally, it is a widely-observed phenomenon that inexpensive goods travel for the cheapest visible cost, sacrificing time.

Obviously there must be some way of calculating time otherwise businessmen would rate their goods haphazardly and generalisations such as "high-cost goods attempt to reduce time at the expense of cost" would not prove true. For businessmen to be able to make these decisions they must be able to view both money and months in terms of a common denominator, probably by reducing time to a cost. Direct comparisons can then be made between one journey which costs $X more and takes Y days less to complete than another route, and a routeing decision reached.

The crux of the matter surely lies in the fact that, the more expensive the shipment, the more is money tied up in its movement, and the longer that movement takes, the longer will that money be idle. Money itself has a cost which is measured by taking the amount of extra

money that it could earn if it were invested elsewhere, a sum that is represented as its rate of interest. (This will vary from place to place, and even from person to person, depending upon each person's sureness of speculation.) Thus for money to be invested in goods being transported from one place to another the return or profit must be at least equal to that which could have been earned by investing it elsewhere. Otherwise the money would be invested or the shipping procedure speeded up.

Thus we can now measure the cost of time. If a consignment can be moved one of two ways, the one taking three days and the other eight, then the extra cost of shipping the slower way is 5/365 multiplied by the prevailing rate of interest and by the value of the consignment (as will be realised at its next purchase). If this resultant sum is greater than the saving in freight costs then the shipper will find it cheaper to ship the quicker way, despite the extra freight costs.

The following examples should make this clear: if commodities to the value of $10,000 are involved in a journey of one week's duration the cost of time to the shipper will be, (if the prevailing rate of interest is 5%), 7/365 x 5/100 x $10,000, or a fraction over $10. If the commodity were one thousand tons of coal, the freight rate for the seven day voyage by ship might well be $1,000, giving a total cost to the shipper of $1,010. An air-line company would probably charge $200,000 for the transport of the same commodity between the same places, but the journey would be completed in one day, giving time costs of approximately $1.50 and a total cost of $200,001.50. Now, however, consider that the shipping lines will still charge one dollar per ton and air-lines $200

per ton and that the commodity being moved is not 1,000 tons of coal but 10 lbs. of platinum. The important point to notice is that its price is still $10,000 and that the costs of time will still be $10 by ship and $1.50 by air. However, at the same rates the ship would only charge one half of one cent for the journey, totalling $10.00½, while the air-line would charge two hundred times as much, or one dollar, but the total sum is still only $2.50 so that the shipper will normally send this consignment by air.

Admittedly these are two extreme cases but they were taken to show by exaggeration the complementary effects of time and freight costs. If time had been the only consideration, both coal and platinum would have travelled by air, and by water if freight costs were the only consideration. Taking them both into consideration, the routeing decision depends not only upon the length of time taken and the freight costs but also upon the total value of the consignment and upon the prevailing rate of interest. It is not just because goods are valuable that they travel most quickly -- for 1,000 tons of coal is just as valuable as 10 lbs. of platinum -- but, because of the differing ratios of value to weight, and therefore to freight rates, those that have a high weight compared to their value will tend to travel less quickly than those with a low weight/value ratio. (7).

This discussion on the factor of time has revolved around aircraft versus ships but this can and does equally apply to land transport. The cost of time to a shipper applies irrespective of whether the good is on land, sea or air, or even stored in a warehouse -- twenty-four hours will still cost the same. Thus we can measure the cost of frequency in exactly the same way, multiplying the average waiting period by the rate

of interest and the amount of money involved. We can consider the hypothetical example of the export of machinery from Port Arthur to Europe. The freight rate by ship from Port Arthur may be $100, and from Montreal $90. The rail rate between the two cities is $30 and the presumed cost of one day is $2.00. The rail journey takes two days to Montreal whereas it takes seven days by ship whence it is eight days to Europe. Provided there was no waiting for ships involved the cost direct by ship from the Lakehead would be $100 + 15 x $2, or $130. If the consignment went by rail to Montreal the cost would be $90 + $30 + 10 x $2, or $140. putting the machinery in the hinterland of the Lakehead. However, Montreal has an average of 90 sailings a month for Europe, while the Lakehead has but one, giving frequency costs of 33 cts. (four hours) at Montreal, and $28 (fourteen dys) at the Lakehead, which would then route this consignment through Montreal ($158 as opposed to $140.33).

In this way, it can be seen that it becomes a simple step to measure the time cost of all alternative journeys -- it is not the individual parts of the journey that matter as much as the time cost of the whole movement from producer to consumer. Here it is of course similar to the freight costs in that it is the total costs that matter, but we have of necessity to study the constituent costs in order to obtain that final cost.

Thus we now have two basic costs -- of actual freight rates and of time -- and one minor cost, that of the additional port charges, but there are several others which are still to be considered; the factors or costs of insurance, of bulk economies, and of indirect economies, and also the unknown human factor. These are studied in the succeeding sections.

F. The Factor of Insurance Costs.

The payment of a premium to insure goods against loss or damage while in transit is an essential part of the cost structure upon which routeing decisions are made. But while it is an important cost little is known about its structure and how it can influence routeing decisions and the size and shape of a port hinterland.

From an interview with a marine insurance agent (8) it appeared that little could be said in the way of useful generalisations. Insurance premiums are set individually for each consignment and vary with the value of the goods, with the length of the journey (both in miles and in days), and with weather conditions, especially ice. All these had been expected, but they also vary with the individual insurer's knowledge of the shipper, of the various carriers, of the age and nature of the ship, of the port, and on such factors as recent successes or failures of the insurance company and even upon any hunch that the insurer may have.

As a result it is extremely difficult to assess either the costs of insurance or the effect it has on the size and shape of port hinterlands. There appears little rhyme or reason to the premiums charged although one interesting point could be noted and that is that they vary according to the port through which the goods are to be handled. Factors such as inefficiency in the port, slackness, damage, and pilferage have to be accounted for somehow due to the deleterious effect it can have on the size and shape of a port's hinterland, and it is in insurance that the effect of this factor can be measured as a cost. For example, the very high rate of pilferage at Montreal is reflected in higher premiums on otherwise identical shipments, while the nominal pilferage and damage

at Halifax reduces the insurance costs, and thus the total costs and therefore expands the potential hinterland of the port.

The general conclusion was reached however that the factor of insurance, an important constituent of total cost as it is, has to be left out of the equation. The reasons are primarily because it is almost impossible to obtain worthwhile figures, but secondly because, the shippers themselves being unable to forecast the insurance rates for their various possible routeings, they must make such decisions without recourse to costs of insurance. They may indeed be able to forecast fairly well the cost of the premium by reference to previous charges on similar consignments but it can at the most be but a hopeful estimate. A third reason for deleting the factor of insurance is the belief that the geographical variations in insurance costs are of insufficient size to merit them as an important routeing factor. It is possible in fact to regard the cost of insurance as a constant, as a certain percentage of the total costs. In this way, although the actual costs of insurance are important to the shipper they will not affect his routeing decision, nor the nature of the port hinterlands. The major disadvantage of so doing appears to be the fact that we then have no cost to reflect the factor of port damage and pilferage.

G. The Factor of Bulk Economies.

It has often been noted that large, busy ports are generally associated with large hinterlands and this has now been put into mathematical form by Gould (9) and tested with success by Shaffer (10). This we have seen is partly due to the efficiency and economies arising in large ports which lead eventually to lower port charges and more frequent

sailings, and thus less total cost to the shipper. However, this is not the only reason why large ports continue to expand their hinterlands. Perhaps the most important attraction of a large port is the number of ancillary commercial services that it can offer -- the various 'Exchanges' of London not only reflect the prominent position of that port but partly help to account for it. Many such commercial functions are to be found in large ports such as financing, warehousing, auctioning, wholesaling, and -- perhaps most important from our point of view -- customs brokerage and consolidators. All these services exist to facilitate trade and, while they undoubtedly form an extra cost to the shipper, the goods they offer in return are professional advice, speed, convenience, and cheapness.

The economies to be gained in this way are derived from the large-scale nature of the activities and are termed economies of bulk. Similar to economies of scale in manufacturing, one can see that it needs little extra commercial and financial capital to deal with the movements of twelve casks of wine than with one, so that an importer or pool operator may be able to despatch to their respective destinations twelve casks, each at a cheaper rate than the individual consignor or consignee could have obtained on his own. Similarly an importer could decide to import a whole consignment of cacao, full well knowing that the amount far exceeds the demands of the usual hinterland of that port. However, by buying in bulk he is able to obtain it more cheaply than neighbouring ports and is able to sell it in their marginal hinterlands as a result. This is one of the important ways in which ports become more powerful than their neighbours and which could lead to that port becoming known as a cacao wholesaling centre.

As with imports so with exports. A manufacturer, wishing to export a few machine parts to Ireland, may well find that it is cheaper for him to export through Montreal than Toronto, despite the proximity of the latter. However, customs brokers and pool operators are able to achieve more favourable rates in almost every aspect of cost because they are dealing in bulk. Thus a broker in Toronto would be able, probably, by amassing a large number of small consignments for Ireland and western Britain, to obtain a cheaper total rate for the machine tools than the manufacturer could have obtained on his own. Perhaps a broker in Montreal could have quoted an even lower cost, but it is assumed that manufacturers deal with local brokers. The point thus stands out that, due to economies of bulk, the goods have been re-routed, as well as transported more cheaply, and this on a large scale could thus affect the size and shape of port hinterlands.

The difficult point to know is whether many consignments are re-routed as a result -- we know that the only effect of note to the shipper is a reduction in cost, but we do not know which way that good would have been routed if it had responded purely to the cost and time factors relevant to the small consignment as opposed to the bulk consignment. According to a firm of customs brokers, (11), the majority of manufactured and general cargo goods using the major ports are handled by such firms, so that their importance should not be underestimated. Questioned as to whether the separate firms moved the goods along special routes, favouring certain ports and shipping lines, the answer came back that the sole function of such firms was to move goods as cheaply as possible and that if they failed to do this their customers would soon find a firm that did.

Thus it is seen that the firms themselves abide by the assumed economic law of cheapness, but this does not help solve for the earlier problem as to the re-routeing of goods due to bulk economies, especially as to the scale and importance of such re-routeings.

H. The Factor of Indirect Economies.

One obvious point remains to be made and that is that the original assumption -- that every shipper will route his consignment as cheaply as possible -- may not always or even usually be correct. Drs. Kerr and Spelt discovered many such apparently uneconomic decisions in their questionnaire to the Toronto industrialists (12) and some of their findings, as well as additional ones, might profitably be stressed.

Firstly, it must be remembered that the decision to route any consignment as cheaply as possible is not in itself an end, but is merely one of the methods by which a firm diminishes its costs and attempts to maximise its profits, the last being the end to which, supposedly, all business decisions appertain. Normally the desires for profit maximisation and for the minimisation of transport costs can go ahead concurrently, but it often happens -- just how often it would be useful to know -- that the two desires are not compatible and that the best interests of a firm as a whole are achieved when certain goods are routed a comparatively uneconomic way. This may often occur when the firm owns its own transportation system, normally a fleet of trucks but possibly also of ships. Once the vehicles have been purchased it is in the best interests of the firm to fully utilise them even at the expense of increasing actual transportation costs.

Another example occurs, notably in Canada, where a branch or sub-

sidiary firm is dictated to by the parent corporation that controls it. Thus many U.S.-owned Ontario firms ship their goods via New York or other American ports instead of through Toronto or Montreal, despite the increased cost, because the corporation as a whole can then make greater economies due to it trading in bulk.

Similarly, movements of goods for a government or a firm may well be decided with respect to such matters as political prestige or possibly for advertising purposes, the extra costs of movement being balanced hopefully by such benefits as, possibly, the support of a declining transport industry, or of increased sales to the firms. It is well-known that many small firms run their own fleet of vans and trucks, despite the fact that public carriers would be cheaper, because of the increased advertising they can thus achieve.

With such reasons behind the movements of goods it appears almost impossible to predict through which port each of these consignments would be routed, as they are subject to many hidden and subtle points of economics. One can only hope that such apparently irrational movements account for less than ten per cent of all shipments. There is some justification for thinking that the percentage would not be higher as the customs brokers themselves believe that they handle much of the tonnage, while we must also allow for some of the remaining firms to behave in the expected fashion, shipping their goods at the lowest possible total cost. Nevertheless, it is clear that we shall never be able to predict the movement of every consignment, even if we were given every relevant fact, for the reason that no two people would agree, for example, on the amount of increased sales that would be derived from the use of a company fleet of

vans, even though they knew how much more it would cost them to transport their goods this way. With benefit/cost analysis on the increase in companies perhaps we shall see a rationalisation of such problems, but there will still be no short cut to the knowledge of how these consignments will eventually be routed.

J. The Human Factor.

Much has been written and much more has been wondered about the importance of non-economic or irrational decisions. On a point of definition, non-economic is understood not to include those routeing decisions, discussed in the preceding section, which lead to overall economies at the expense of increased transportation costs, but to include instead those decisions which are partly the result of personal whim, folly, or ignorance, or from trading inertia. As has already been stated in section A of this chapter, it is believed that such decisions are few and will remain few, for a small firm would soon go out of business while a large firm would normally notice its mistakes. Again, we are not to assume that just because a decision was based on non-economic factors that the consignment would be routed through another port and alter the port hinterland network: it may be routed the correct way for the wrong reasons.

Of these possibly the most difficult to account for is politics. We have already seen how politics can affect routeing decisions by its influence on rail rates, on subsidisation of certain routes compared to others, and by the imposition of customs duties and other costs for transportation across political boundaries. Often, however, politics works in a more active manner concerning the routeing of

commodities and affects directly the size and shape of hinterlands by making its own routeing decisions.

It is believed that most routeing decisions made by politicians will take account of economic or least-cost factors, but often the economic nature of such decisions is overridden by other considerations, such as assistance to depressed areas, or the use of government owned or controlled transportation facilities. An example here is the Canadian government's shipments of grain to the U.S.S.R. and China, most of which is shipped through Canadian ports (and especially through those belonging to the National Harbours Board) despite the fact that some of this grain could be routed more economically by way of American ports.

The number of routeing decisions made by the government will of course vary from country to country and it is believed that the percentage is higher in those countries where most of the factors of production, as well as the transportation facilities, are state-controlled than in those where the individual makes most of his own decisions. We can thus see that, although this model was proposed to fit all areas at all times, it now appears that it will predict less accurately under the former conditions. This of course is based on the (unproved) assumption that individuals and companies are more likely to route their goods an economic way than are politicians and governments.

Of the other factors, personal whim, folly, and ignorance are nearly always uneconomic in nature, but trading inertia may possibly represent the same kind of total economy of the firm noted in the preceding section. The firm that stated that they had shipped through Montreal for thirty years and would probably continue to do so despite

the new lower rates via Toronto (13) may well have been acting on economic grounds, although possibly without fully realising it. This firm would have a stable trading mechanism for routeing its goods through Montreal, and the upheaval, the necessity to seek new brokers, financial assistants and commercial links who would not offer low rates to a new customer, plus the possible disuse of a trucking fleet and the laying-off of its staff, all these are intangible costs which may well overcome a saving of a few cents on the actual transport of its goods. So that, although this firm admits to a trading inertia, it may still be the sympton of a normal firm, maximising its profits.

To many manufacturers these intangible costs of change, measureable only in sociological and psychological terms, may amount to more than the few tangible dollars saved. As each manufacturer is different, so would be his subjective measure of such factors, and a socio-psychological study is really required to help us. These subjective measurements will no doubt also vary from place to place and from time period to time period, an American manufacturer responding more quickly to a changing cost pattern than say, an Ethiopian or an Indonesian.

Here the subject begins to slip further and further away from Geography and even from economics, into the depths of sociology and psychology and we are left without a satisfactory answer. The best that appears possible is to ignore all such uneconomic factors and hopefully assume that they account for but a small fraction of all decisions and that even so they may rarely alter a decision and thus the shape and size of the final hinterland.

K. The final Model.

In this chapter we have been studying the effects of those factors which it is believed help to account for the size and shape of hinterlands

by affecting the routeing decisions of shippers. What is required now is a simple model which will be able to incorporate relevant facts and enable us to account for hinterlands that have been observed, or draw up those where data of actual freight movements is difficult to obtain, or to predict movements of hinterland boundaries as a result of foreseeable changes.

We have assumed that goods will normally travel as cheaply as possible and that, as there is nearly always a variety of routes between any two points, they will be routed that way which gives least total cost. So that, if all consignments of a commodity from a certain area travel through a given port then, for that commodity, that area is in the hinterland of that port. If the commodity is distributed through several ports, the area is considered to be in the hinterland of that through which it ships most. It is believed, however, that, once allowances have been made for varying destinations, such cases will not regularly occur except where two or more ports offer exactly the same total costs so that each consignment is despatched according to the next scheduled departure from any of the ports.

Although many factors were considered and noted in the review of literature in chapter two, fewer of these were selected for discussion in this chapter, and fewer still will be incorporated into the model. Of the land transport costs the only ones to be used in the final equation are the total freight charges paid by the shipper to a carrier (or, alternatively, the costs of using his own transport system) and the costs of time. For the costs of marine transport, again, the only factors considered important are the total freight charges payable and the costs of time. The only costs of handling to be considered are those port charges which

the shipper pays directly, the others being incorporated already in the terrestrial and marine freight rates. None of the other factors will be incorporated for reasons already given -- the impossibility of predetermining insurance costs; the belief, or rather hope, that the economies of bulk will reflect themselves in improved transportation facilities, notably in the frequency of sailings; and the almost impossible task of forecasting those movements based on indirect economies or that include the random decisions of the human factor.

All factors are eventually reducible to cost, even time itself as we have seen, but for the purposes of testing there are just five major figures to be collected -- the total freight rate from the producer to each port; the total time involved in moving goods from the producer's warehouse to each port, and in effect the dockside; the additional port charges; the total marine freight rate; and the total time taken from dockside to dockside. In the following equations they are referred to as A, B, C, D, and E respectively. In addition, i is the area in question, j is the port in question and k represents the destination port, while Tik(j) is the total cost of moving one unit of the goods from i to k via port j.

The equation of total cost then is:

(1) $Tik(j) = Aij + Bij + Cj + Djk + Ejk$

This gives us the cost of moving a certain consignment from i to k via port j and the procedure is repeated for each port, the area being classed as in the hinterland of that port which registers the lowest total cost (T).

The testing technique is developed more fully in the next chapter but first we should notice an important feature of this model which it is

believed is found in actual commodity movements and thus in actual hinterlands. This is the fact that the cost taken into account by shippers is always the final cost, T, and that while they attempt to minimise each component part of that total cost, rarely will all costs be at a minimum value. Thus, while shipping through the nearest port minimises factor A and probably factor B, factors D and E will only be minimised if the port that is nearest the producer is also nearest to the destination, while there is no real likelihood of the port also having the lowest port charges of all ports. This is extremely obvious, but is put here to stress the fact that no one of these five factors is any more important than the others in that it rarely determines the final movements on its own. Thus, because the minimisation of total cost is the only important result, there is no real basis for believing that goods will be shipped through that port to which they are nearest, both in terms of cost and of time. For this reason alone it is felt that many former hinterland studies have missed out an important point by looking at only one aspect of the trade movement, either maritime or terrestrial -- the two are finely balanced, and it is the sum of the two that will decide the routeing of goods.

The elements of this equation consist entirely of these five aspects of cost, and the extent to which these costs are actually taken into account by shippers may seriously limit the predictability of the resultant model. Thus if all shippers acted in a completely rational manner, reducing their shipping costs to a minimum, then the predictability should be very good; whereas an increasing number of uneconomic decisions

may have an important effect. We must not lose sight of the fact also, that the effectiveness of this model may also be impaired by unsound logic, or its testing affected by imperfectly collected data, or by such a fact that many shippers may not be able to estimate correctly the costs of time. These are all serious limitations which, as in any non-laboratory science, must be studied carefully.

Footnotes to Chapter IV

(1) Sargent termed this the 'geographical' hinterland and discussed other factors as modifying this, giving us the 'actual' hinterlands that we observe (in his Seaports and Hinterlands, (London: Black, 1938), p. 5).

(2) Reduced from the U.S. Geological Survey map, NK 17-6 (30-L), Buffalo, Eastern U.S., 1:250,000 series, 1952 edition. The road data is for 1950. This region was chosen (a) because it has a road network developed behind an approximately straight coastline, and, therefore suitable for transference to the study area, and (b) because maps of this area were readily available. The actual area represented in Fig. 4 is 56 x 28 miles, with the top of the page in a south-easterly direction, and with the suburbs of Buffalo at lower left and Jamestown at upper right. Although the area shown is not the regular 200 x 100 miles this makes no difference except that the whole of the network appears coarser than it really is: however, no one area of the map is out of proportion with any other part.

(3) The only modification is that each port is given a railway station.

(4) W. Warntz, "Transportation, social physics and the law of refraction", The Professional Geographer, (July 1957), 2-7.

(5) N. M. Shaffer, The Competitive Position of the Port of Durban, Northwestern University Studies in Geography, no. 8, (Evanston: Northwestern University, 1965), esp. pp. 51-55.

(6) U. S. Geological Survey, op. cit.

(7) Perishable goods are treated exactly in the same way as other goods except that a proviso is put in concerning the time limit. Perishable goods will travel as slowly as any other good if they can still reach the market before they lose their value. If quicker transport is needed, the choice is not between different routes as much as between travel and non-travel: a good, with a life of three days, may have to travel by aircraft if the ship takes five days. However if the combined cost by air exceeds the market price at the distant point then the good will not be shipped at all.

(8) Mr. J. Lemieux, Eagle Star Insurance Co. Ltd., Toronto.

(9) P. R. Gould, Transportation in Ghana, Northwestern University Studies in Geography, no. 5, (Evanston: Northwestern University, 1960), appendix A.

(10) N. M. Shaffer, op. cit., p. 223 ff.

(11) Border Brokers Ltd., Toronto.

(12) D. Kerr and J. Spelt, "Overseas trade at the port of Toronto", Canadian Geographer, VIII(1956), 70-79.

(13) Ibid. p. 77.

CHAPTER V

FORMULATION OF THE MODEL

In the last section of the preceding chapter, an equation was given which showed the basic cost components of the total cost involved in moving a commodity from i to k through port j. By contrasting the various values given for each port j we should be able to state that, if the shipper was acting rationally and was not ignorant of cost conditions, the commodity would be routed through that port which registered the lowest total cost. As we have already stated, a hinterland is no more than a statistical distribution obtained as a result of the summation of all such decisions. Theoretically then we could observe the nature of hinterlands by merely repeating the experiments in different places and dn different commodities.

From a practical viewpoint however, this simple equation soon attains massive proportions, so massive that the resultant map of hinterlands may not merit the effort. Let us consider the problems inherent in an attempt to delimit hinterlands within South-Western Ontario, an area bounded on the north and east by an approximate line from Port McNicoll to Toronto, the area shown in Figure 10. The problem is very straightforward -- to apportion this area to the various ports in commodity hinterlands, (1).

The first question to ask is the number of possible ports that

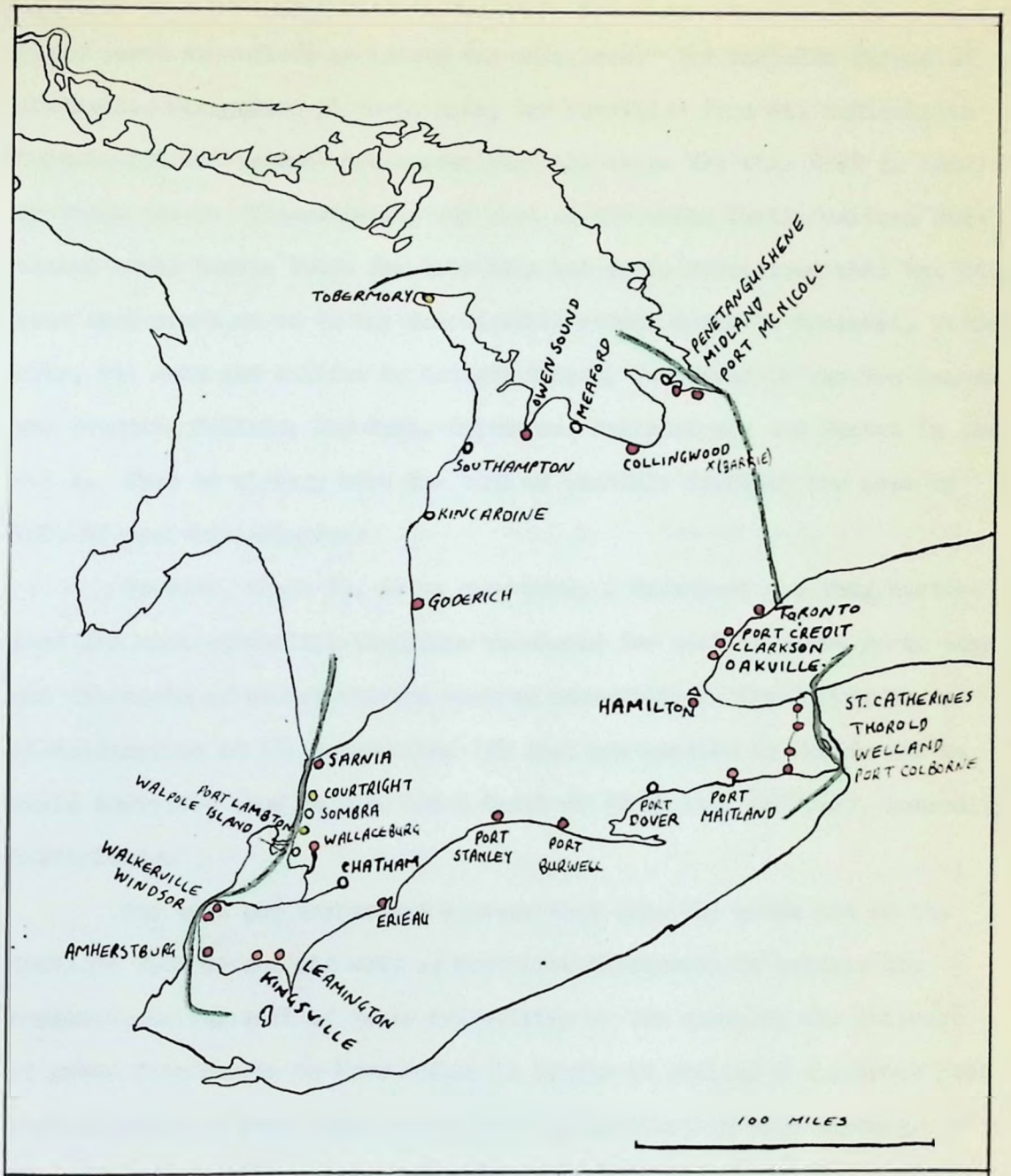

Figure 10. The Ports of South-West Ontario

——— = South-West Ontario
o = ports handling more than 100,000 tons in 1963
o = ports handling less than 100,000 tons in 1963
o = ports handling only one commodity in 1963
o = ports with no trade in 1963 (source: D.B.S.)

could serve as outlets or inlets for this area. The Dominion Bureau of Statistics recognizes 36 ports along the coastline from Pt. McNicoll to Toronto (2) but we must not assume that all trade for this area is handled by these ports. Theoretically any port on the whole North American continent could handle trade for this area but it is considered that the only ones that would do so to any considerable extent would be Montreal, Quebec City, St. John and Halifax in Eastern Canada, Vancouver in Western Canada, and Detroit, Buffalo, New York, Baltimore, Philadelphia and Boston in the U.S.A. Thus we already have the task of possibly dividing the area up into 47 port hinterlands.

However, there is, as we have seen, a different possible hinterland for each commodity, therefore we should for each of these ports work out the costs of moving all the various commodities. The D.B.S. has a classification of 181 commodities (3) that are handled in Canada and we would therefore need to work out a total of 47 by 181, or 7,667, commodity hinterlands.

The work has emphasised however that once the goods are on the dockside this is not the end; we must also differentiate between the destinations for each of these commodities -- for example, the shipment of goods from Barrie to Port Arthur is likely to utilize a different port to that which it would have chosen had the destination been Hamburg. Therefore we shall have to treat each port outside the area as a possible destination. The number is, of course, countless -- in the first two weeks of July, 1965, regular cargo liners left Toronto for 81 foreign ports and seven Canadian ports, not counting the destinations of all the tramps that leave port. In the Great Lakes alone there are 54 Canadian

ports exclusive of this study area, and approximately 230 American ports (4), although many of these are fishing harbours. In the whole of 1963, ships engaged in commerce between Toronto and 29 Canadian ports and between Toronto and 64 foreign countries, discounting the many U.S. Great Lakes destinations. (5). Perhaps a realistic estimate of the number of destinations involved would be 150, which, multiplied by the 7,667 commodity hinterlands, gives us 1,150,050 hinterlands classified by commodity, port, and destination.

Thus there are over one million possible hinterlands that could be defined, and this is before the equation is started upon. The next question to decide is the number of regions that are to be included in the study area. There are 23 counties south and west of the line from Port McNicoll to Toronto, and 233 townships. Supposing for a moment that it was decided to draw hinterlands on the basis of the township, this would give us 268 million individual equations of the form

$$Tik(j) = Aij + Bij + Cj + Djk + Ejk.$$

For each of these equations there is of course a large amount of work involved -- to solve for Aij, the total freight rate from the producer to the dockside, requires knowing both the rail freight rate, if applicable, and the road freight rate to choose that which is cheapest; to solve for Bij, the total time involved in moving between the two, requires an evaluation of the time taken by rail and road, and a translation into actual cost by multiplying it with the interest rate and the value of the consignment; an evaluation of Cj, the additional port charges, requires knowledge of the same; the total marine freight rate, Djk, to the port in question requires knowledge of the actual rates charged and also an estimate of how much it would cost to charter a ship for that

journey if there was no regular service; and to solve for Ejk, the total time taken from dockside to dockside, one would need to know both the average length of time taken on the journey, and the average waiting-period for a vessel bound for that place.

The calculations required will now assume astronomical proportions and, if deemed necessary, another two variables could be entered, one of seasonality, studying the hinterlands in summer and comparing them with those of winter, and one by dividing the movement of goods into imports and exports. Little has been said on this latter division, it being believed that, if there was an occasion where the same kind of good were sent from two places to each other, they would travel the same route only in opposite directions. An example of this might occur with the newspaper industry, copies of Toronto newspapers being available in certain cities in Europe, while Toronto herself will import European newspapers, normally by air, but often by sea.

Figure 11 summarises these variables and diagrammatically shows the escalation of the number of calculations required. The number is well beyond the capacity of the human being and would seriously test the stamina of a computer. One is thus left with the alternative of reverting to a description of the trade movements of one or at the most a few ports, as has been usual with hinterland studies, or a drastic pruning of the variables can be undertaken in order to reduce the problem to manageable proportions.

The latter course is taken and much of the rest of this chapter will show how such simplifications can be made without having a too adverse effect on the meaningfulness and usefulness of the resultant pattern

Original totals			Revised totals	
Equations	Number	VARIABLES	Number	Equations
47	47	PORTS	47	47
8,507	181	COMMODITIES	3	141
1,286,250	150	DESTINATIONS	8	1,128
299,649,650	233	AREAL UNITS	233	262,824
27,150	TOTAL NUMBER OF HINTERLAND MAPS			24
299,649,650	TOTAL NUMBER OF EQUATIONS			262,824

Figure 11. Variables Affecting the Numbers of Hinterland Maps and Equations

of potential hinterlands. Reductions in the number of ports and areal units are seen to be derogatory, for reasons outlined below, but it is believed that great reductions could be made in the number of commodities studied and the number of destinations without seriously affecting the predictive ability of the resultant model.

There are, as we have seen, 36 ports in the study area and of these seven had no trade at all in 1963 while four traded in only one commodity. Nevertheless, it is believed that the model would suffer from the withdrawal of any of these because one of the interesting questions it is hoped such a procedure will answer is why these seven ports had no trade, and why the other four traded in one article only, the article always being a low cost to weight good such as limestone, sand and gravel, and coal. In addition, we should be interested in potential hinterlands as much as in actual hinterlands. Such a procedure might well show that Tobermory was in a good position to control the seaborne trade of the Bruce Peninsula but, through poor facilities or lack of populous hinterland, had never realised that potential.

Similarly, it is intended to keep the township as the basic areal unit and not to study hinterlands in terms of counties. This is partly because the counties are often of great size but also due to such facts that, for example, Essex County contains five ports, and one would not be able to distinguish any one port hinterland from that of any of the other four.

Thus the number of hinterlands has already reached 10,951 (233 x 47), beyond human capabilities, but still only a few minutes' work for a computer.

The main simplification is expected to come as a result of a

very large reduction in the number of commodities. One commodity would obviously not give us the whole answer for it has often been observed that two different commodities will travel between the same two places but by different routes: one will tend to maximise the marine part of the journey while the other maximises the terrestrial distance. This is clearly not the result of marine freight rates per ton/mile being higher than the land rates in one case and lower in the other, because the ratio of these two is roughly comparable for all goods, marine rates being lower.

If all goods were shipped according to the cheapest freight rate only, there is no doubt that all goods would travel the same route, therefore another factor must be invoked to explain the observed divergences of trading routes for different commodities. This factor has already been alluded to and is of course the factor of time. This factor, as we have seen, varies in importance directly with the value of the good, and indirectly with the freight rates -- thus the higher the freight rates are, the less important will be the costs of time to shippers. Freight rates are not necessarily a function solely of the weight of the consignment but may also take into consideration the value of the good, its volume, or even its nature -- offensive or dirty commodities usually being required to pay higher rates. Therefore the actual ratio that is of importance is the value/freight rate ratio rather than the value/weight ratio as outlined in the previous chapter.

It is considered that, as the importance of the factor of time varies with this ratio, if ratios were worked out for various commodities, one could use these ratios to select commodities that could be used in

the analysis. Thus it is assumed that a high value/freight rate ratio commodity would tend to minimise the time factor, and a low value/freight rate ratio commodity would tend to disregard it. It is believed that, as commodities with the same ratio would tend to travel the same way, one could limit the number of commodities to a small number, chosen by any method, from this continuum of ratios. Other methods could be used to select commodities for study, such as the five most important commodities entering into the region's trade, or selected by nature -- a foodstuff, coal or minerals, manufactured goods and so forth -- however, it is felt that, if a research worker took a low ratio, a medium ratio, and a high ratio good, this would be the most useful selection.

In the same way, it is felt that a large number of the destination ports could be left out without any great effect on the usefulness of the model, providing of course that the few chosen were representative. Perhaps the most scientific way of selecting these ports is to weight each one according to the amount of trade it has with the study area and to randomly choose from this weighted sample any number of ports. This, however, entails the collection of data on traffic movements which, for the purposes of predicting potential hinterlands, we assume are not available. An alternative is to hand-pick a representative sample of ports so that, for example, it includes a large port and a small port, one in Lake Huron and westwards, one in Lake Erie, and one in Lake Ontario; and at least one abroad. This would be a matter of reasoning and much discussion, but it is felt that seven or eight ports, varying in direction, size, and distance, should be sufficient. A larger number would probably be more useful if it could be coped with.

Assuming that a first model would not be ambitious enough to attempt a division into seasons or direction of trade this would leave (at 47 ports, 3 commodities and 8 destinations) a total of 1,128 hinterlands to be drawn, which, when multiplied by 233 for the number of areal units, gives 261,824 equations.to solve, still a small number by computer standards. (This final number is less than 0.1% of the original, unsampled number of 268 million.)

Attempts would then need to be made to simplify the equation so that its five components may be easily calculated. It is assumed from the start that most of the components would require an inhuman amount of effort to calculate or to obtain as actual data. Reference might be made to the collection of trucking rates: these would need to be collected to show the actual prevailing rates from the centre of 233 townships to 47 ports for each of three commoditygroupings, a total of 32,853 separate rates. Then the same would need to be done for rail rates where rail connections were provided and the more expensive rate discarded.

It is believed however that much of this could be replaced by correlating rates with actual straight-line distances between points. The resultant factor would not be extremely accurate but it may well be accurate enough -- this could be seen in the r^2 value of the correlation, It may well be found that rates per straight-line mile are higher in some areas than in others and a modifying factor could be built into the function of distance. The computer would be told to work out trucking rates for all combinations of townships and ports, but would only work out rail rates if it had been told that both port and township were served by a railway station.

For dealing with land time a similar method could be employed, correlating a sample of actual or calculated time values against the straight-line distance to obtain a function that will be able to calculate the time and then multiply itself by the value of the good to obtain the cost of the time. This is the same method for both road and rail but difficulties are going to be encountered in trying to describe the frequency of freight trains unless each port and each township is given a code-number which states the number of freight trains per day or per week, the computer working out the waiting-time by looking either at both or at the more infrequent one only. This would require much testing before it could be used. The costs of time would be added to the respective trucking and rail freight costs and the total which is lower would be stored, and the higher one discarded. (7).

One problem in connection with this that will probably be found is that some ports will consistently have lower rates than others, notably with rail but also with trucking, due to political pressures and business conditions. It would be very difficult to build these into the function of freight cost described above, and so it is suggested that, for such cases, the relevant port charges be modified. The port charges for the three commodities will be fed in as constants, but these can be modified beforehand to allow for favourable or unfavourable rates, or inaccessibility, or even connected with port facilities: thus port charges can be increased if the port is incapable of taking normal vessels or decreased if it has a large number of commercial undertakings. The extent to which such modifications are made may seriously affect the results and thus once again prior testing and validation is required.

Shipping costs can be treated in the same way as land costs, correlations being effected between sample freight-rates and distance to the port, and shipping-time assumed at a constant, average speed.

It may be necessary to feed in data concerning regular shipping services between any of the 47 ports and the 8 destinations. Apart from the eleven ports outside the study area, four ports have scheduled links with the other continents and six have a Great Lakes service. For ports without any regular services at all or to certain of the destinations, enquiries will have to be made as to the average cost of obtaining a tramp steamer or of diverting a regular liner. The charge will no doubt vary from port to port as will also the cost of time involved in waiting for such a ship. If it is at all possible to obtain a fair representation of such facts these would also be fed into the model as constants, in a similar way to port charges. All the data that will be needed for such a model are summarised on figure 12.

All this time the computer will have been adding and storing up the total cost for the movement of commodity A from area i through port j to destination k. It then repeats this for the other 46 ports, continually rejecting higher costs and printing out at the end the port which handles this trade most cheaply. In this way pictures of the 24 hinterlands can soon be drawn up, many of the smaller ports probably not getting any zone of dominance whatsoever, especially where there are two or more in the same township.

The major remaining task is to analyse the results and if possible compare them with the hinterlands as they are actually observed. No doubt there will be many divergences, some of them major, but analysis of these

CONSTANTS

Location of ports, destinations, and the centres of townships on a grid network;

Commodity values, and general rate of interest;

Additional port charges for each commodity;

Cost of diverting liner or inducing tramp to call in;

Rail freight train frequencies for each port and township;

Liner frequencies between ports and destinations;

VARIABLES

Road, rail, and marine freight rates for each commodity obtained by straight- or curved-line correlation of sample rates with straight-line distances;

Road, rail, and marine journey times obtained by straight- or curved-line correlation of sample times with straight-line distances

Figure 12. Data Required for the Proposed Model.

divergences should point to the faulty part or parts of the model, and lead to its repair.

The result of all this is that we should then be in possession of a model which could predict reasonably accurately the potential hinterland of any port for any commodity or group of commodities. But we would be no nearer the goal of delimiting the actual total, or combined commodity, hinterland, as defined on p. , because we have nowhere included the actual trading levels which would enable us to compare and weight the various commodity hinterlands. The data that would be ideal, from the point of view of the hinterland definer, would be an analysis by each processer or manufacturer of the locations or sources of his raw materials and the tonnage from each, and the tonnage of finished goods delivered to any area: thus a furniture manufacturer in Brantford would need to state the source of his wood and the markets for his furniture. However, such information is unlikely to be published or even collected due to problems of secrecy, but this is the ideal to which data collection should be directed.

It is however felt that pictures of actual hinterlands may be more easily collected by discussions with harbourmasters. Ports usually record the origin and destination of each cargo on ships' manifests and these can neither be used wholesale or sampled, and amounts of various goods allocated to the townships of origin or destination. The value to each port of each township would then be obtained by multiplying out the commodities by the port charges.

It is stressed again however that since the method prepared here is for a prediction of potential commodity hinterlands, it may need much changing to be able to describe past or present combined commodity hinter-

lands. As aforementioned, it is impossible to predict future combined commodity hinterlands with any degree of confidence due to regular changes in world trade and prices, wars and slumps. The potential hinterlands would be unchanged by all this, but the actual hinterlands would not, their dynamic nature being noticed even when all the routeing factors are constant.

Footnotes to Chapter V

(1) It will be remembered that total or combined commodity hinterlands cannot be constructed unless the individual commodity hinterlands are weighted according to the amount of port revenue obtained from each, which requires knowledge of all actual shipments. As this study believes that potential hinterlands are of more importance than actual, but necessarily past, hinterlands, actual trade movements have been discounted as a factor in the analysis.

(2) Dominion Bureau of Statistics, Shipping Report 1963, (Ottawa: Queen's Printer, 1964), p. 243; also unpublished material.

(3) D.B.S. op. cit., p. 246.

(4) D.B.S. op. cit., p. 243; and Waterborne Commerce of the United States, 1963, Part 3, Waterways and Harbors, Great Lakes, (Detroit: Corps of Engineers, Department of the U.S. Army, 1964).

(5) D.B.S. op. cit., tables 23 and 24.

(6) This section on the systematisation of transport costs owes much to G. Törnquist, Transport Costs as a Location-Factor for Manufacturing Industry, Lund University Studies in Geography, Series B, no. 23, (Lund: Royal University of Lund, 1962), esp. p. 43-52.

CHAPTER VI

CONCLUSION

This thesis set out to discover whether we could predict the size and shape of a port's hinterland without actually referring to the flows of goods which make up that phenomenon. To this end a survey of work already produced on hinterlands was undertaken, this leading us to believe that vagueness of definition and a lack of supporting statements for the various involved factors has been much to blame for our present lack of knowledge on the subject of hinterlands.

It was therefore decided to allot much of the time and energy available to the formulation and presentation of a definition of a hinterland which would meet the basic requirements and conditions of that phenomenon but which would also be, in Sargent's terminology, a scientific definition, capable of application to the facts. It is felt that the definition is indeed scientific and that it is as near to describing the salient features of the hinterland as it is possible for any scientific definition to be.

Thirdly was undertaken an *a priori* reasoning as to the factors involved in determining the size and shape of port hinterlands. Three factors were deemed of great importance and they were 1) the factor of total transit cost from producer to consumer, 2) total time taken for that movement, and 3) the effect of non-economic and seemingly

non-economic decisions. The unpredictable nature of the last factor makes it extremely difficult or even impossible to account for, and so the final equation, which expresses the total costs involved in the transference of a commodity between two land points via an intervening stretch of water, is the summation of land transport costs, marine transport costs, any additional port charges, the cost of time involved with land movement, and of time involved with marine movement.

It was then attempted in the preceeding chapter to formalise this equation and systematise its components so that a model could be constructed which would approximate to reality with the minimum input. However, it has not proved possible to be able to test the predictability of this model for reasons outlined in the previous chapter. One reason is that the correlations of freight cost and time with straight-line distance will have to be undertaken, although actual shortest road distances could be used instead if the area was not excessively large. Another reason is that there is an insufficiency of processed data concerning the origins and destinations of goods passing through ports. Ships' manifests are sometimes available, but the assembly, processing, and evaluation of this raw data would take the single-handed researcher many years. Thus it was mainly on the basis of time limitations that the testing was not pursued in this work.

Nevertheless, we can still appreciate the model's applications and limitations. The extent of the model's predictive capacity at the moment is that, if all shippers routed their goods with respect only to minimising the cost of such movements, then a certain network of

hinterlands could be drawn up that should represent reality. If this assumption of least-cost routeings is valid, then the model should be of great value in enabling us to picture past, present, and near future hinterland distributions. We have not attempted to prove this assumption and this can be considered a serious limitation to the usefulness of the model. A survey by economists of routeing decisions might well help us to know the average percentage of 'economic' as opposed to 'non-economic' routeings. The higher this percentage, the greater is the applicability of this model. Unfortunately, little more can be said on this matter until such a study has been undertaken.

The other major limitation of this model is that it can only predict single commodity hinterlands for a port and not the total commodity hinterland. This is because the latter is comprised of the various commodity hinterlands which then have to be weighted according to the value of revenue each gives to the port. Thus unless we know the actual commodity flow we cannot weight the individual commodity hinterlands, and even if these were available we should be able to picture only the past and possibly the present pattern of hinterlands, but definitely not even the near future. The best that we can say for the future, at the moment, is that if the present trading levels are maintained, or certain trading trends are maintained, then the single commodity hinterlands could be weighted and the total commodity hinterlands predicted. A most useful piece of research here would thus be a concerted effort to predict the trading levels for different areas in the future, these figures then being used to weight the single

commodity hinterlands. In other words, if we postulated that an undetermined flow of goods were to take place between an interior point S and an overseas port K, the model could tell us the most economic routeing for such a movement, and this would be the route actually chosen if the model had any predictive value; but, since the number and amount of shipments concerned is unknown, the model definitely could not state how much of this commodity would or even should be routed this way. As we than cannot weight the individual commodity hinterlands, we cannot obtain the total port hinterland, unless we postulate certain trade levels.

Even so, it is considered that this model has contributed to the understanding of the size and shape of port hinterlands. Perhaps accurate prediction is still a long way off -- if not impossible, but we should now be in the position to assess, qualitatively if not quantitatively as yet, the effect upon hinterlands of certain known variables. Thus we could quite well assess the effects on the commodity hinterland boundaries between Hamburg and Marseilles of a postulated closure of the Suez Canal. We can also foresee the effects upon port hinterlands of a rise in any of the freight rates, of the varying tendencies of dock workers to strike, of a change in the rate of interest, and of increases in vehicular speeds. The model still lacks sophistication in that it has not been proved yet to be able to accurately predict these effects, but perhaps the time will not be long before the work this thesis has started can be continued, tested, refined, and perfected, so that eventually we shall be able to predict accurately the size and shape of port hinterlands.

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