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Some Structural Features of the Canadian International Shipping Network, 1990

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Introduction

The marine international database is based on Canada Customs cargo control documents (A6 General Declaration). This document is filed by the carrier at the port where cargo is loaded or unloaded from a vessel. The form contains information on cargo movements, including the cargo loaded or unloaded and vessel characteristics. In this study, three elements of that database are used: the Canadian handling port, the foreign origin/destination port, and the vessel flag. The intensity and diversity of activity at Canadian ports is indicated by the total cargo that they handle, as well as by the range and degree of fleets' and foreign regions' representation in their markets.

A network approach is taken to explore the structure of these data, as it affords an analyst the ability to examine the similarity of objects rather than simply the magnitude of the transactions. To this end, cross-tabulated data are reconfigured and represented in a multidimensional scaling - derived space. The greatest benefit of this technique is its ability to generate graphic depictions of cross-tabulated data. In addition, the resulting configurations may reveal relationships within the data table that would not, otherwise, be immediately evident. Specifically, this study attempts to identify and to define the core of Canadian international shipping activity.

The Language and Concepts of Networks

The specific term 'network analysis' is associated with many disciplines. These include operations research, transportation engineering, and some areas of the social sciences (e.g. Hillier and Lieberman, 1986). However, at its most basic level, the term *network analysis* refers to a broad approach to interpreting data. Throughout its various applications, the central emphasis of network analysis is on the relationships between objects and the contribution of these relations to the overall system structure. Network approaches, as such, fundamentally differ from analyses that focus on the specific attributes of objects.

The language used in network analysis helps to clarify its main purpose:

- Objects, or entities, in a system are called *actors*.
- When actors are situated close to each other or share common characteristics, they create groups that are described as *cliques*.
- The 'closeness' of actors within these groups is based on *proximity* and *similarity*.
- The existence and the strength of shared characteristics among actors is used to measure *cohesion*, in either specific cliques or in the total network.

In short, network analysis is used primarily to examine patterns of interaction and to find the areas of systems where activity -- the manifestation of power and control -- is focused.

The principal actors in international shipping are the Canadian handling ports. An obvious relationship between these ports is their spatial proximity to each other. In fact, one traditional way of describing port activity is to place it in the context of a physical region. For example, the discussion might begin by comparing Atlantic ports to Pacific ports. Within these broad groups, the next step would be to describe the importance of one port relative to another.

These ports are also related by the movement of vessels. In this study, for instance, two data tables define some of these relationships. One is a tabulation of foreign origin/destination countries by Canadian ports. The other is a table of shipping fleets (vessel flags) by Canadian ports.

By examining their patterns of cargo handling and transport, it is possible to describe the port system in other than strictly regional terms. In the first data table, Canadian ports are compared in terms of the regions towards which their handled cargo is oriented. The second matrix compares Canadian ports in terms of the registries that are represented in their share of vessel traffic. Conversely, for the foreign origins/destinations of cargo and flag states, similarities are revealed in their pattern of representation at Canadian handling ports. These relationships are the basis for identifying and describing the core of the Canadian international shipping system.

Networks of Places

The hierarchical organization of a port network generally follows that of the urban economic system. This structure is described by a simple core-periphery model. For example, the Canadian urban system is focused on a densely populated and spatially compact super-region that spans the Windsor-Toronto-Montreal axis. This is the basic core-periphery structure. In contrast, a dense fabric of populated places throughout the United States produces a more spatially complex network of cities. Viewed from east to west, a core-periphery-core pattern is evident, as in: New York - the Midwest - Los Angeles.

In the urban economic structure, heartland areas serve to focus political, social, and economic activity. These centres utilize resources of local hinterlands and, given an appropriate geographic and economic setting, some may eventually exploit the resources of ever increasing territories. Furthermore, within a national system, the potential exists for several metropoles to emerge as primary centres of production and consumption. They would function as increasingly important control points in a larger urban economic network. This essentially describes the evolution of a core. It is noted that these functions may also be present in peripheral areas but their diversity and intensity in the core region should be much greater.

If the function of cargo handling activity in the shipping system is a reasonable surrogate for political, social, and economic activity in the urban system, then a similar core-periphery hierarchy may be expected in the port network. In this situation, the physical movement of goods from port to port is a type of exchange that parallels the communication linkages between cities. Because shipping is necessarily constrained by a physical network, regional associations are expected to be very important.

However, it is also possible to conceive of a model of port structure that is based on their functional similarity as well as their physical proximity to each other. In this paper, market orientation is taken to indicate functional similarity. This is expressed in the foreign origins and destinations of cargo, as well as the fleets that are represented in their vessel traffic.

By portraying the port system in this way, a reference point is also defined for historical comparisons and for evaluating the many and varied projections of the future of the Canadian shipping system. In effect, operational-level data is made meaningful from a top-down perspective. Areas of application would include program and policy evaluation, particularly in transportation or regional development. Thus, the principal goal of this study is to identify and to describe the core of the Canadian shipping network, providing a benchmark, in 1990, of the relative positions of actors in this system. This is especially important in terms of (a) the membership and cohesion within its core, and (b) the decay of activity from its central core to its periphery. The configurations derived in this study serve as a reference point in time, against which past and future changes may be compared.

Methodology

This paper develops two simple examples of how a network approach may be used to explore the underlying structure of data, specifically: in defining groups of objects. In this case, the 'group' of greatest interest is the core of actors in the Canadian international shipping network. To do this, two commonly used cross-tabulations of data are adapted from the 1990 marine international file: (i) the principal foreign origins and destinations of cargo at leading Canadian ports and (ii) the principal flag states that are represented at leading Canadian ports.

These are essentially weighted frequency tables and, as such, the data are essentially univariate. There are also problems with scale. Because dry and liquid bulk are such a large component of the cargo, the numbers are quite large. In this way, the actual quantities of cargo are a reflection of the commodity specialization of each port. While this contributes to the importance of each port to the overall network structure, it is certainly not the only aspect of a port's role in the system. Thus, data must be manipulated such that relationships among Canadian ports, foreign regions, and shipping fleets are clearly shown. In addition, the peculiarities of the quantity being measured, i.e. cargo tonnage, may influence but not unduly distort the portrayal of the overall structure.

Multidimensional Scaling. Within the broad area of network analysis, various methods are used to draw out the relationships of objects. One of these, multidimensional scaling (MDS), is a technique for graphically representing the similarity of objects. The salient features of MDS are summarized in this section. Readers are referred to Kruskal and Wish (1978), who provide a full development of this technique and its relation to conventional factor and cluster analyses.

Developed by psychometricians at Bell Laboratories in the 1960's, MDS is simply a method of expressing the similarity of objects, δij, as distances in 'real' space, *dij*. The relationship between similarity and real distance, $dij=f(\delta ij)$, is most often based on a Euclidean distance metric, although there are others that may also be applied. Thus, given this relationship, MDS simply estimates coordinates in a derived space such that $f(\delta ij)-dij$ is minimized. The 'success' of the rescaling is measured by an objective function which, in classic MDS, is called *Kruskal's Stress*. The stress in the derived configuration is similar to a goodness-of-fit measure, in that it represents the degree to which the derived configuration represents the properties of the similarity scores.

A solution may have more than two dimensions and their appropriateness is judged on two levels. One is based on the stress of the configuration. Stress tends to decrease with a higher number of dimensions. In other words, additional dimensions are used to express more of the variations in the similarity scores. There are associated difficulties, particularly of artificially resolving random variation and local minima. Furthermore, as dimensions are added to the solution, the data structure also becomes more cumbersome to represent in standard graphic displays. More importantly, it also becomes more difficult to interpret them meaningfully. As such, it is common to take a two- or three-dimensional solution, because the resulting structure is more meaningful, even though lower stress might be achieved in configurations with higher dimensionality.

In general, interpreting an MDS solution is no different from interpreting any other scatter of data points. That is, the configuration is initially interpreted on the basis of what is contained in the original cross-tabulation. Then, it may be possible to discern the effects of other variables that were not explicitly measured. The principal difference, however, is that the axes on these graphs represent different aspects of a single variable, rather than two or more measured variables. As such, they are named by the analyst *after* they are constructed. Particularly in exploratory analyses, a visual interpretation is usually sufficient. When this approach is taken, it is noted that the actual placement of the axes should not constrain interpretation. In this paper, the axes of the derived configuration are not shown. Instead, the following discussion refers to *interpretive* axes (which are similar to how a calculated regression line might fit the data scatter). To make the interpretation more rigorous, supplementary techniques from the families of regression and cluster analysis might also be applied. The one chosen depends upon the specific nature of the similarities being studied.

Data Manipulation. Each table is then manipulated in two stages: transformation and rescaling. In the transformation stage, the table is first dichotomized based on the grand mean. From the binary table, row-by-row (in this case, country-by-country and fleet-by-fleet) and column-by-column (or, port-by-port) joint occurrence matrices are constructed. This step creates, in effect, similarity (or, proximity) matrices. Finally, the similarity matrices are rescaled to produce the structures shown in Figures 2, 3, 5, and 6. These transformations are available in many of the commercial statistical software packages. However, there are some that have been developed and documented explicitly for the analysis of networks. In this study, UCINET was used (MacEvoy and Freeman, 1987; [1]).

Canadian Ports and the Foreign Origins and Destinations of Cargo

A cross-tabulation of cargo origins/destinations and leading Canadian handling ports (Figure 1) is rescaled by MDS to produce the structures shown in Figures 2 and 3 [2]. It comes as no surprise that the physical locations of both Canadian ports and foreign origins/destinations contribute to these configurations. It is more important, however, that they suggest a core-periphery hierarchy of Canadian ports that is conditioned by both the total quantity of cargo handled and the range of each port's exposure.

In Figure 2, ports with higher volumes of cargo handling are found towards the centre of the configuration while ports that handle less cargo are found towards the edges. Vancouver, Sept-Iles, Port Cartier, Montreal, St. John, and Halifax are all quite central to this diagram. At each of these ports, in excess of 12 million tonnes of cargo were handled in 1990. At Prince Rupert, Come-by-Chance, Hamilton, and Quebec, the volume cargo handling was lower. These four ports occupy the upper and lower edges of the graph.

In addition, two axes are suggested on Figure 2: regionality (east and west) and market orientation (transborder and overseas). These generally describe some functional aspects of these ports. This is particularly true for Prince Rupert, a Pacific coast port with a strong overseas orientation, and for Hamilton, an inland port whose principal market (81%) is the U.S.-Great Lakes region. Sept-Iles, Port Cartier, and Montreal are central to the physical structure of the port system. They are also central to the structure shown here. This position is likely related to the co-dominance of U.S. and overseas cargo movements.

Figure 2 also illustrates the challenge of fitting linear axes to this type of data. This is particularly true for Quebec and Come-by-Chance. Their placement in the diagram belies their actual market orientation. That is, cargo transactions with U.S. regions account for 43% of the handled volume at Come-by-Chance; this type of exchange is only 16% of the activity at Quebec. Their positions on the diagram would have suggested otherwise. This aspect of the rescaled configuration is drawn out to emphasize the need to verify the interpretation with a supplementary technique.

In Figure 3, the five highest-ranked regions (in terms of total tonnage) are clustered together at the centre of the graph. As in Figure 2, the absolute quantity of cargo transported generally tends to decrease from this central group and towards the edges of the graph. The structure appears to be quite cohesive, possibly because only leading regions were used in this analysis. As such, the separation of core and periphery is not very dramatic. Nevertheless, the U.S.S.R., Nigeria, and Denmark -- perhaps Germany and Italy, as well -- are represented as peripheral actors in the network. This is related both to their relatively low ranks, among leading regions, as cargo origins/destinations and to their generally low profile at the core ports.

Again, physical location contributes a great deal to relationships between origin/destination regions. This is shown along a Pacific-Atlantic axis on Figure 3. Another aspect of these regions' positions in the configuration is their importance as markets of the core ports. This is shown on the markets axis (principal-secondary). In addition, this feature may explain the distance of Japan and the U.S.-Great Lakes from other central regions, i.e. the U.K. and the U.S.-Atlantic area. Although these two regions are very prominent, in terms of total tonnage handled, their greatest representation is not at core ports -- most of the cargo exchange with Japan is through Prince Rupert and, for the U.S.-Great Lakes, it is through Hamilton. Otherwise, the profile of each region generally increases from the bottom left to the top right of the diagram [3].

Canadian Ports and Vessel Registries

A number of countries are prominent in leading Canadian international shipping, not as points of cargo transfer, but as flag states. This situation developed because vessels are able to sail in an open register instead of a true national flag. National fleets, such as the Canadian and U.S. registries, retain a fairly consistent share of the cargo handled in their home countries through legislation that controls the participants in regional shipping. Other states, however, are active in international shipping more as broad administrative bodies than as transfer points of goods. They have been given various labels, for instance -- open registries, flags of necessity, or flags of convenience.

The distinction between national fleets and open registries is related to long-standing differences in interpreting the United Nations conventions, which govern the registration of marine vessels. Traditionally, the Liberian and Panamanian registers have been the most dominant of the open registries. Additional flags of convenience have been created within the last ten years and they have shifted some cargo share away from the historic leaders. The dramatic emergence of the Bahamian fleet exemplifies this change.

A cross-tabulation of flag states and Canadian handling ports (Figure 4) is rescaled by MDS to produce Figures 5 and 6. Again, the physical location of the Canadian ports is an aspect of the derived structure. However, in comparing Figure 2 and Figure 5, it is interesting that the same ports tend to be central to both graphs but they are more tightly clustered in the latter. This type of compact core is also evident in the configuration of flag states.

Based on the representation of flag states in cargo transport, Figure 5 suggests a core-periphery structure in much the same way as Figure 2. In this graph, the dominance of Canadian vessels generally increases from top-left to bottom-right. Cargo handled at Hamilton, for example, is almost exclusively (80%) transported by the Canadian fleet while, at Vancouver, less than 5% of the cargo movement involves Canadian vessels. On the bottom right of the graph, at Come-by-Chance, the Canadian fleet is not represented at all. In contrast, the relative dominance of the Japanese fleet generally increases from the top to the bottom of the graph. Note that the greatest proportion of activity at Prince Rupert is by Japanese vessels (37%). Ports at the top portion of this axis are characterized more by codominance between several prominent registers than by the overwhelming presence of any single one.

In Figure 6, there is a general decline in the total tonnage transported, from the centre of the configuration and towards the edges. Moreover, similarities among the flag states appear to be most strongly determined by regions of operation. This axis runs from bottom-left (Atlantic-oriented) to the top-right (Pacific-oriented). In this case, regional orientations are based on the Canadian handling ports at which these fleets are represented. The registers that appear at the top-centre of this graph -- the Philippines, Singapore, Korea, China, Cyprus, and Japan -- primarily serve the Pacific ports. Central to this structure is a mixture of true national fleets (e.g. Canada), traditional flags of convenience (e.g. Liberia, Panama), and emergent open registers (e.g. Hong Kong, Bahamas). These fleets serve a greater range, in that they exhibit no particular preference among their regions of operation.

In Figure 6, the peripheral fleets -- Italy, the U.S., the U.K., Yugoslavia, and Vanuatu -- are distant from the principal clusters. This is generally related to their comparatively low share of the total tonnage transported and to a tendency, in varying degrees, to favour one region of operation over another. The one exception is the Italian fleet, whose representation at leading ports is consistent but proportionally low.

In the context of power and control brokerage, an interesting possibility is that this configuration may be a manifestation of conference liners' activity. Because they behave essentially as a cartel, the target markets, commodity niches, and fleet deployment patterns of the major liners will necessarily have considerable influence on the overall structure of the shipping network. Particularly since administrative arrangements (i.e. vessel registries) are so easily changed, the manner in which these lines respond to shifting markets and general change in the business climate may be shown by their tendencies to redeploy their vessels from one flag to another.

These are the types of responses that would determine rapid changes in the positions of new registries, such as the Bahamas and Vanuatu, relative to the traditional flags of convenience. For instance, if a version of Figure 6 were generated for 1985, it would be possible to compare the position of the Bahamian fleet in relation to the traditional flags of convenience. This would indicate the degree to which this register, over a five-year period, had displaced the traditional flags of necessity. If this exercise were to repeated for 1992 data, then the Vanuatu registry would clearly be the one to watch. Because its position, in 1990, relative to the core is likely comparable to the that of the Bahamas, in 1985, relative to that core, it is reasonable to expect a similar displacement effect.

Of course, these comparisons would have to be made within some broader context -- particularly, the general competitive climate within the world merchant fleets. At any rate, the point is made that both the technique of representation and the general concept of a core-periphery structure do provide a framework for a more meaningful interpretation of these data.

Identifying the Core of Canadian Shipping Activity

From their relative proximity in Figures 2 and 5, the ports of Vancouver, Sept-Iles, Port Cartier, Montreal, and St. John may be described as the core of shipping activity. This is not terribly surprising as they are, in fact, the five largest ports (in terms of tonnage handled) in international shipping. A more interesting outcome is in establishing commonality among ports that range from the Pacific, to an inland seaway, and to the Atlantic coast. The essence of this shared characteristic is their range of exposure. The markets that they serve range from U.S.-transborder to overseas regions. The representation of various shipping fleets is also quite diverse. Thus, the concept of the core as a focus of activity may be shown.

By these same criteria, the other leading ports take less prominent roles in the shipping network. For example, Prince Rupert, Come-by-Chance, and Hamilton appear along the edges of both configurations (Figures 2 and 5). Aside from handling less cargo than the five largest ports, these are in positions quite distant from that core. This indicates that their strong regional orientation has the effect of restricting their influence in the overall network.

The ports of Halifax and Quebec are neither clearly central nor clearly peripheral to the structure. In the case of Halifax, its range of contact with foreign regions (Figure 2) is offset by the dominance of the Liberian fleet (Figure 5). The opposite is true for Quebec, whose slightly wider range of fleet representation (Figure 5) is offset by its concentration on Atlantic markets (Figure 2). Therefore, these ports have some elements of both core and peripheral functionality.

The membership and cohesion of this core may vary slightly if all the Canadian handling ports were to be included in the data table. In taking this alternative approach, variations on core and periphery membership may arise. The tendency of actors to move between core and periphery may reflect the wider range of cargo handling activity that is represented in a larger matrix. However, if these comparisons are repeated for a wider range of attributes, it may be argued that the tendency of ports to move between core and periphery indicates an intermediate functional tier -- or, a *semi-core* (after Green, 1987).

As we have shown with the ports of Halifax and Quebec, positions of control (in tonnage handled) and range (as opposed to specific market niches) may not be consistent across all attributes. Therefore, the stability of this core must be tested by incrementally adding the other actors to the data table. In doing this, it will become possible to separate the effect of scale from that of true functional differences.

A similar argument may be made for the foreign origin and destination regions, as well as the flag states. In each of these cases, the principal constraints on an expanded analysis would be (i) the reliability of data for the smaller ports, regions, and fleets, and (ii) the limits of the available software and hardware.

Conclusions

By reconfiguring two data tables with MDS, a number of relationships among Canadian handling ports, foreign origin/destination regions, and flag states may be shown.

One of the more important aspects of these relationships is the similarity that is shown among Canadian ports. These are primarily based on their market orientation and that is, in turn, reflected in the range of shipping fleets that are represented in each port's traffic. On these criteria, Vancouver, Sept-Iles, Port Cartier, Montreal, and St. John emerge as the core of Canadian shipping activity. Although some additional testing is required, it may also be possible to identify an intermediate tier -- a *semi-core* -- among Canadian ports, on the basis of their consistent proximity to core ports. The remaining ports are quite distant from the core and, as such, they may be considered peripheral to the international cargo shipping network.

In terms of foreign origin/destination regions and flag states, a number of interesting questions are posed. Some are methodological in nature, which include the roles played by supplementary techniques and data. These would be most useful in explaining the derived structures (particularly the dimensionality), as well as in identifying true cliques and measuring their cohesion. Another issue is that of change through time, and the ability to demonstrate this with MDS. An example of core displacement among the flag states was discussed.

Further, it is noted that these results are preliminary and they must be further refined. In this regard the principal issues are: the sensitivity of the technique, the quality of data, and to test interpretation with supplementary data.

- Variations on the structures derived in this study may be produced by applying other transformations or scaling algorithms. For example, a different configuration may be derived by dichotomizing the table based on a different measure. Another alternative would be to retain the rank-order of the cross-tabulation, rather than transforming the values to binary data. These configurations might also be compared to the results generated through similar techniques, such as principal components analysis.

- It is important to verify that these structures were derived from genuine functional differences among the handling ports, foreign regions, and flag states -- rather than any systematic error in the data.

- To demonstrate cohesion and stability in the core, shared attributes among those actors must be identified and measured. Some may be taken directly from the marine international database, such as an index of the commodity mix. Others, such as the value of containerized cargo or the position of a given Canadian handling port on each vessel's itinerary, would require supplementary data from other sources.

Having provided a benchmark configuration for 1990, subsequent analysis might also compare networks over time to verify that this definition of a core is stable. One good example is the encroachment of emerging flags of convenience on the markets of national fleets and the traditional open registers.

The application of network analytic approaches -- and MDS, in particular -- has clear utility in the study of shipping systems. First, it presents relationships in the data that may not otherwise be found. Graphic representation of these patterns is also provided. Second, these relationships may contribute to developing a unified research framework, within the limits of the data.

Notes and References

[1] In this package, the MINISSA procedure is used for ordinary MDS (Michigan Israel Netherlands Integrated Smallest Space Analysis). MINISSA essentially refines Kruskal's scaling procedure to make it more resistant to local minima. There is not a single comprehensive source of documentation for this algorithm but, together, the explanations offered by Roskam and Lingoes (1970) and MacEvoy and Freeman (1987) are reasonably complete.

It should be noted that, since the basic procedure was derived, several computational algorithms for MDS have been developed. Some, including INDSCAL, are in UCINET; others are available as components of general statistical software (e.g. ALSCAL in SPSS/X). In addition, readers are referred to STRUCTURE as a complementary working environment (Burt, 1991). In addition to providing similar techniques of data representation, this package has some very good discussions of the relationship of MDS to other statistical procedures.

[2] In Figures 2, 3, 5, and 6, the lines that are drawn through the scattergram are intended only to guide the interpretation of these configurations. These lines may be considered *interpretive* axes, in that they are a visual approximation of where a regression line might go through the scatter. The 'true' numerical axes of the rescaled coordinates would correspond roughly to the left and bottom of the figure border.

Some difficulties arise when these interpretive axes are closely scrutinized. For example, in Figure 2, "Prince Rupert, a Pacific coast port with a strong overseas orientation" appears just above the east-west axis but halfway along the transborder-overseas axis. In short, the exact positions of each point, with respect to both the axes, are difficult to interpret.

This may be simply an indication that linear models are not the most appropriate representation for these data. In fact, these data are much better suited to interpretation through a clustering procedure. In this way, the discussion would begin with the shared characteristics of clusters. Next, the contrasts between the isolates and the clusters would be described in order to explain their separation. Nonetheless, given the exploratory nature of this study, visual interpretation is sufficient to provide a basic initial explanation.

[3] Notable exceptions are Denmark and Australia, whose positions in the configuration suggests that their profile at core ports should be equivalent to that of the U.S.-Pacific. In fact, they are

not. Australia, in particular, has its strongest showing at Vancouver but it is far overwhelmed that by port's cargo exchange with Japan.

BURT, R. 1991. *STRUCTURE.* New York: Center for the Social Sciences, Columbia University. The package is intended as a primer in the development and application of network analysis. However, its demands on hard disk space are excessive and a general familiarity with statistical analyses is assumed.

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Figure 1. Cargo Handled at Principal Origins and Destinations:
International Shipping at Leading Canadian Ports, 1990

Foreign Origin/Destination	Canadian Handling Port (quantities measured in metric tonnes)										
	Come-by-Chance	Halifax	St. John	Montreal	Port Cartier	Quebec	Sept-Iles	Hamilton	Prince Rupert	Vancouver	Total (at leading ports)
Japan	131 358	220 099	136 864	30 379	-	49 508	1 806 640	5 015	7 243 012	23 269 108	32 891 983
U.S.-Atlantic/Gulf	3 432 350	3 925 336	3 332 802	2 001 952	1 419 583	545 087	4 255 936	126 005	55 311	638 393	19 732 755
U.K.	2 520 987	1 604 949	808 095	1 269 507	1 999 850	3 532 005	881 971	72 591	259 089	1 927 109	14 876 152
U.S.-Great Lakes	-	-	105 414	636 128	2 639 147	1 196 623	4 321 734	4 767 295	-	-	13 666 342
Netherlands	285 724	183 431	382 080	927 469	2 534 040	96 450	2 600 910	114 100	-	742 022	7 866 226
Korea	-	121 587	23 821	96 310	264 775	37 034	344 623	34 393	114 950	6 771 605	7 809 098
China	-	2 421	184 977	19 283	-	10 500	-	8 707	2 146 455	3 687 355	6 059 699
Belgium	-	158 341	141 843	2 658 429	704 861	71 728	448 898	156 772	138 130	734 336	5 213 339
Saudi Arabia	-	14 807	2 262 176	79 161	513 473	137 591	-	14 893	520 496	707 606	4 250 202
Norway	-	1 084 148	1 153 690	95 047	-	1 345 584	243	2 405	-	438	3 681 555
Brazil	-	1 904	196 440	596 485	33 599	1 060 539	-	17 296	-	1 680 937	3 587 200
U.S.-Pacific	-	2 830	2	18 335	237 409	2 461	-	321	834	4 980 335	5 242 526
Venezuela	-	968 687	929 372	767 796	26 255	411 080	-	11 097	-	86 039	3 200 326
Fed. Rep. Germany	52 352	300 962	143 002	645 598	1 113 053	37 988	395 639	3 799	3 786	328 414	3 024 593
Italy	70 377	296 255	-	615 859	477 812	85 539	567 769	182 368	40 562	521 621	2 858 163
Taiwan	-	142 110	9 585	77 923	-	5 359	-	11 249	18 794	2 293 731	2 558 752
U.S.S.R.	-	2 906	-	202 930	606 973	1 145 513	-	-	292 771	59 285	2 310 377
Nigeria	562 906	481 501	782 525	81 337	-	15 753	-	-	-	2 000	1 926 022
Denmark	27 468	244 949	198 289	266 964	1 021 650	9 131	-	-	14 127	122 112	1 904 690
Australia	91 027	126 659	80 234	147 626	-	9 054	-	-	-	1 268 517	1 723 116
All Other Areas	716 362	2 943 594	1 391 357	2 284 433	2 596 915	1 282 243	1 367 934	336 471	845 295	11 516 372	25 280 978
Total	7 890 912	12 827 478	12 262 567	13 518 950	16 189 395	11 086 769	16 992 299	5 864 778	11 693 612	61 337 335	169 664 094

This table shows foreign origins and destinations of cargo that contributed at least 1.0% to the total quantity of cargo handled. The Canadian ports shown here were the highest ranking, in terms of the total quantity of cargo handled, in 1990.

Figure 2. Leading Handling Ports,
Based on the Principal Foreign Origins and Destinations of Cargo
(Two-dimensional solution, stress = 0.0098)

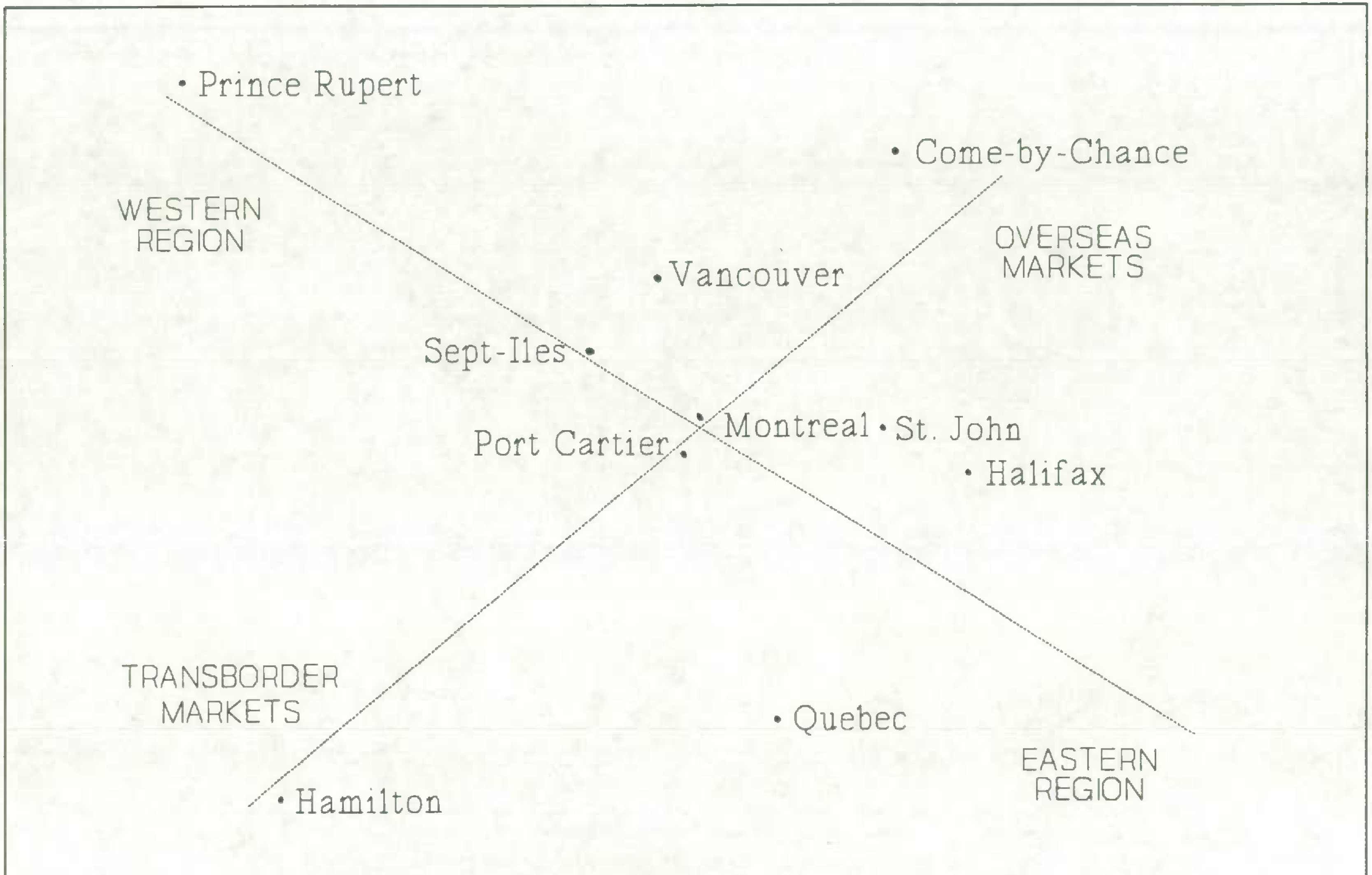


Figure 3. Principal Origins and Destinations of Cargo,
Based on Their Activity at Leading Canadian Handling Ports
(Two-dimensional solution, stress = 0.0494)

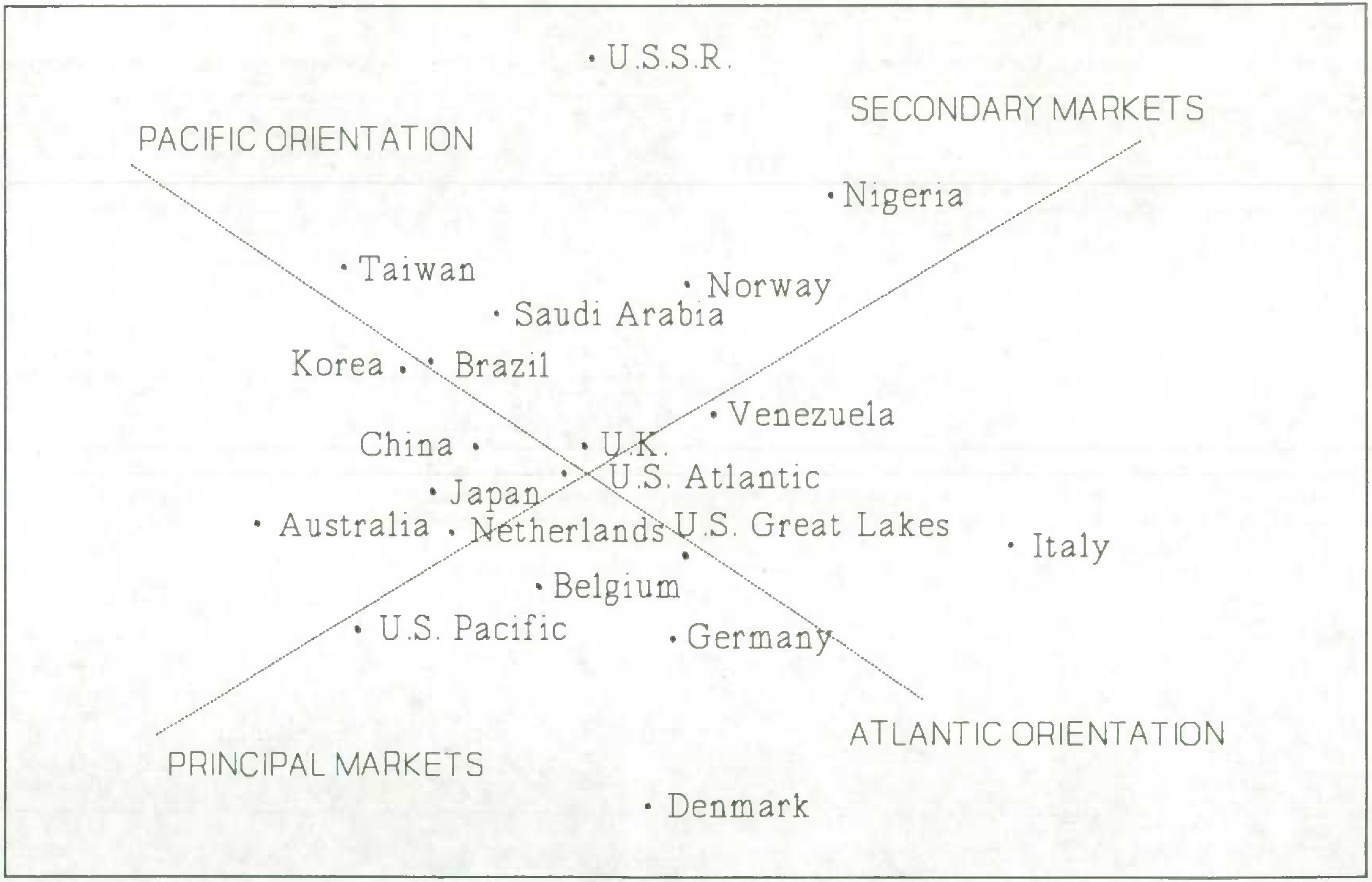


Figure 4. Cargo Transported by Principal Vessel Registries:
International Shipping at Leading Canadian Ports, 1990

Flag State	Canadian Handling Port (quantities measured in metric tonnes)										
	Come-by-Chance	Halifax	St. John	Montreal	Port Cartier	Quebec	Sept-Iles	Hamilton	Prince Rupert	Vancouver	Total (at leading ports)
Liberia	1 740 340	4 039 968	1 996 370	1 679 367	1 663 231	3 547 155	2 332 858	227 908	711 048	7 536 582	25 474 827
Canada	-	416 756	2 017 632	671 300	2 639 147	1 199 422	4 360 036	4 693 256	47 635	2 401 289	18 446 475
Japan	91 027	476 641	-	60 501	168 519	8 052	1 291 465	3 799	4 355 919	10 518 920	16 974 843
Panama	453 844	454 430	549 379	511 586	831 572	733 573	929 969	193 413	1 462 485	9 277 136	15 397 387
Norway	2 451 678	966 347	1 237 029	520 921	718 484	987 922	1 073 189	89 618	264 777	2 309 296	10 619 261
Greece	144 845	55 936	1 760 859	952 036	1 249 478	649 335	1 082 672	159 179	556 944	3 156 719	9 768 003
Bahamas	512 823	792 778	1 130 091	1 268 335	2 025 783	300 681	984 773	34 518	225 848	1 306 251	8 581 879
Korea	-	924	-	25 957	66 302	6 712	-	-	215 803	5 941 431	6 257 129
U.S.S.R.	95 937	11 906	54 384	1 021 570	850 626	1 242 688	23 688	22 472	260 707	1 968 193	5 552 170
Philippines	-	9 500	100 236	158 945	323 349	114 000	-	10 770	405 680	3 703 978	4 826 459
China	-	76 209	-	14 242	191 061	207 767	626 981	-	954 838	2 705 084	4 776 181
Yugoslavia	-	91 470	22 695	1 483 225	1 317 372	103 502	499 063	59 205	165 666	703 576	4 445 774
Cyprus	86 925	163 246	291 209	516 435	682 086	289 199	371 349	55 673	147 775	1 792 011	4 395 907
Hong Kong	-	312 318	178 394	1 261 323	124 485	203 227	538 626	53 099	703 275	865 629	4 240 377
U.K.	117 301	490 907	330 365	610 615	891 264	69 183	567 706	56 695	-	241 601	3 375 635
Singapore	389 256	478 134	267 402	303 794	181 429	165 669	442 799	6 319	129 465	826 388	3 190 655
Italy	285 764	770 351	88 911	210 817	615 752	157 756	134 435	-	53 500	237 428	2 554 714
U.S.	357 518	214 948	426 139	200 436	-	389 770	33 124	58 826	6 170	775 259	2 462 190
Vanuatu	-	242 794	118 660	39 626	-	2 212	562 193	4 983	245 628	668 002	1 884 099
All Other Flags	1 163 655	2 761 917	1 692 813	2 007 920	1 649 454	708 944	1 137 372	135 044	780 450	4 402 561	16 440 130
Total	7 890 912	12 827 478	12 262 567	13 518 950	16 189 395	11 086 769	16 992 299	5 864 778	11 693 612	61 337 335	169 664 094

This table shows flag states that contributed at least 1.0% to the total quantity of cargo handled. The Canadian ports shown here were the highest ranking, in terms of the total quantity of cargo handled, in 1990.

Figure 5. Leading Handling Ports,
Based on the Principal Flag States Represented
(Two-dimensional solution, stress = 0.0578)

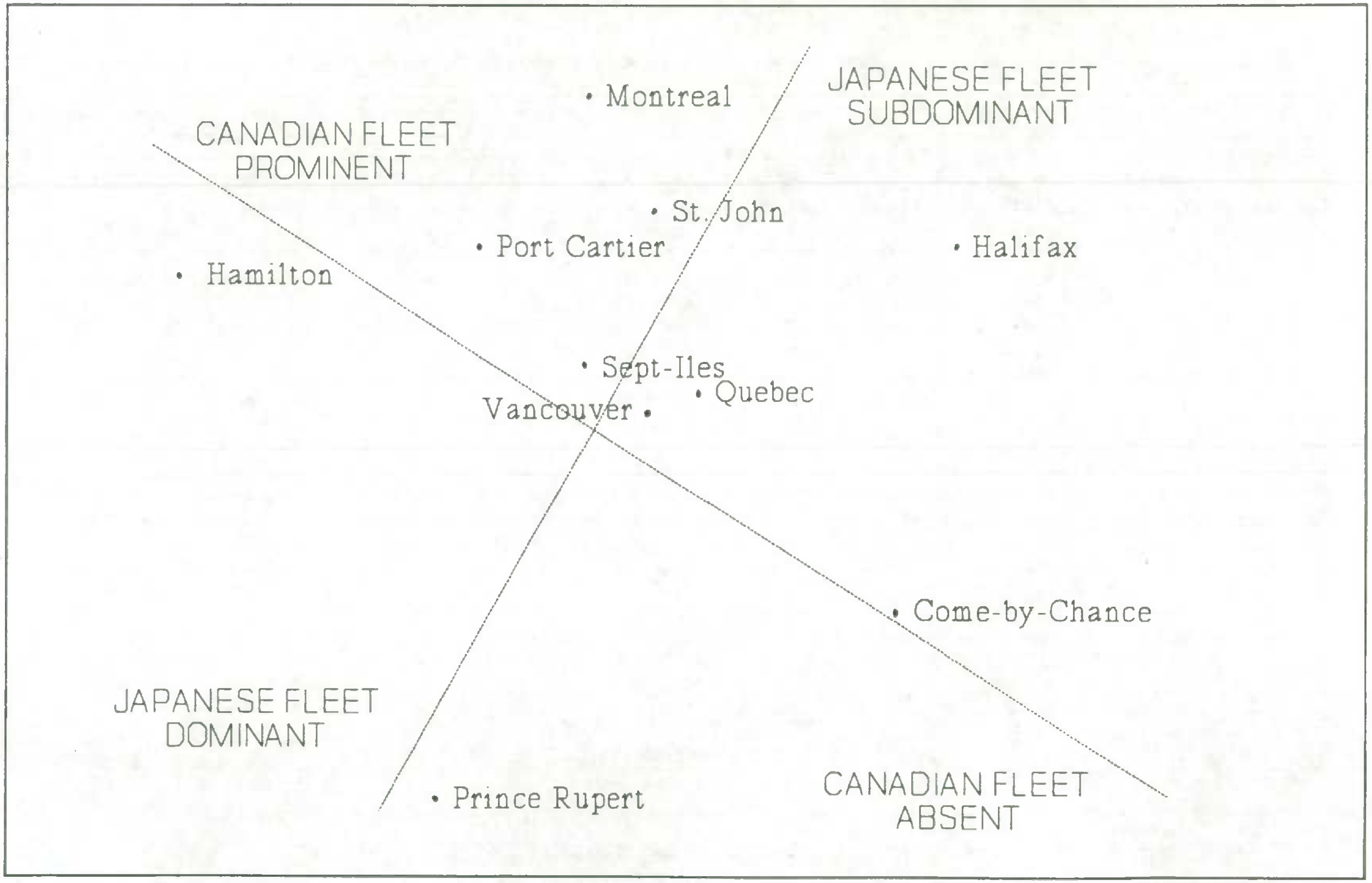
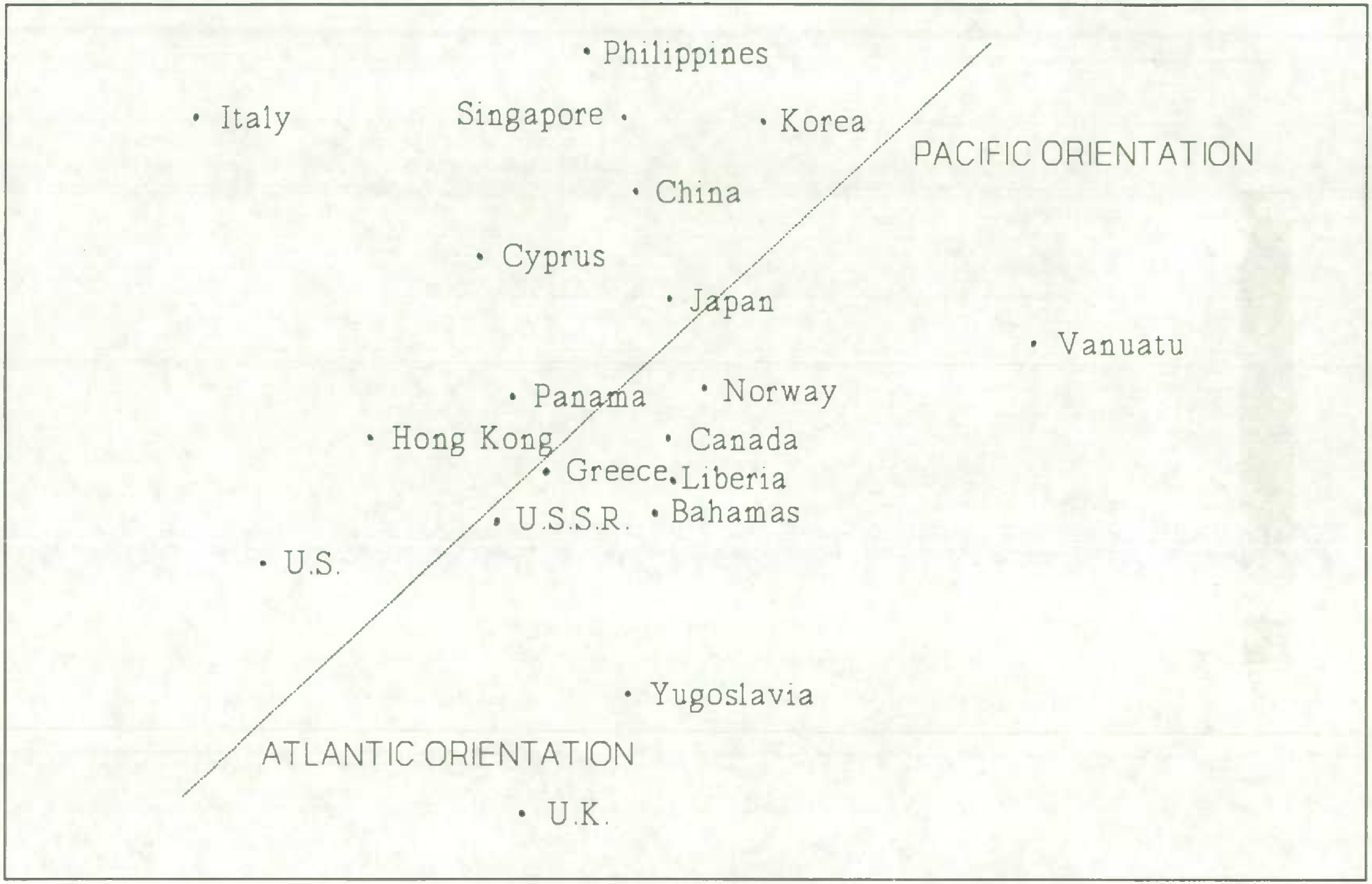


Figure 6. Principal Flag States,
Based on their Representation at Leading Canadian Handling Ports
(Two-dimensional solution, stress = 0.0265)



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