Intermodal Transport of Frozen Poultry Products to Overseas Markets—A Comparison of Physical Performance and Costs of Van Container and Break-Bulk Systems

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PREFACE

This is one of a series of studies by the Agricultural Research Service to find more efficient, less costly ways of handling and transporting shipments of U.S. agricultural products to overseas markets. The study was made to assess the potential of containerized handling and transport in shipping frozen poultry products directly from U.S. processing plants to foreign receivers in overseas markets. Its purpose was to identify the problems and opportunities inherent in adapting the containerization technique to the transport of overseas shipments and to determine how it could best be improved and exploited to meet the needs of the producers and the marketing system.

This research was made possible through the efforts and contributions of numerous individuals and organizations. Valuable assistance and support for the work were received from the U.S. Department of Agriculture Foreign Agricultural Service and the Poultry and Egg Institute of America. Many shippers, receivers, and carriers made their products, facilities, and equipment available for the study. Many such firms and government agencies also made their records available for the researchers. Frank J. Koprivnik, industry economist, formerly with the Agricultural Research Service, assisted in compiling and analyzing the data.

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Intermodal Transport of Frozen Poultry Products to Overseas Markets—A Comparison of Physical Performance and Costs of Van Container and Break-Bulk Systems

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SUMMARY

Research comparing the containerized and break-bulk methods of handling and transport of through intermodal shipments of frozen poultry from the processing plants in the United States to foreign markets overseas showed several advantages for containerized shipping of the product. From the standpoint of physical performance, the containerized technique was far superior to the conventional break-bulk method of shipping, which it has largely replaced as the primary method of transport since this research was begun.

Total transit costs for the van container shipments were generally higher than for the break-bulk shipments, principally because the ocean conference freight rates for the van container shipments were substantially higher than the nonconference rates for the break-bulk shipments.

Evaluation of the physical performance of the two methods of shipping revealed that the containerized method provided more protection to the product from physical loss and damage in handling and from exposure to unfavorable environments during transit. Loss and damage of the shipping containers and product were found to be from one-fourth to one-half percent of the invoice value of the shipments by the break-bulk method and little or none for the van container shipments.

Much of the physical damage to the poultry boxes and the product in the break-bulk shipments resulted from numerous handlings of the individual poultry boxes, averaging about 10 handlings per shipment as compared with only 2 for the van container shipments. The numerous individual handlings of the poultry boxes also led to considerable pilferage in the break-bulk shipments. No pilferage was observed in the van container shipments.

Product temperatures in the van container shipments were maintained at much lower and more favorable levels in transit than they were in the break-bulk shipments. Van container shipments averaged −9° F, whereas the break-bulk shipments averaged +14°.

Since the van containers were never opened from the time they left the shipper's loading dock until they reached the receiver's warehouse, the product was under constant refrigeration and never exposed to the outside air during the entire trip. Exposure of the poultry in some break-bulk shipments to outside air for prolonged periods during transfer of the cargo from one mode of transport to another resulted in partial thawing of some of the product.

No important differences in total transit time were found between the two shipping methods. Although the van container shipments were handled on and off the ship faster than were the break-bulk shipments and sometimes were transported on faster ships, the savings in time thus gained were usually lost in delays at other points in the intermodal transport system.

All the van container shipments were made on American flag carrier ships. All the break-

bulk shipments were made on foreign flag nonconference carrier ships because their rates were 20 to 25 percent below those of conference carriers.

Transit costs were the principal component of transport costs, or the costs of physically moving the product from origin to destination. Ocean freight charges were the largest cost element, ranging from about 40 to 91 percent of total transport cost for shipments by both the break-bulk and the van container methods. Inland freight charges from origin to port of loading and from the overseas port to the receiver generally varied directly with the distances the shipments were moved. These costs accounted for most of the remainder of the transport expense since loading and unloading costs and freight forwarders' fees and insurance constituted a relatively small proportion of the total transport expense.

Transport costs plus import duties for U.S. poultry in foreign overseas markets by both transport methods were significantly higher than the transit costs. Only a little more than a third of the shipping expense was accounted for by transport costs, whereas import duties on the poultry made up more than 60 percent of the shipping costs.

Economic costs developed for the through intermodal movement of the shipments observed in this study show that for the van container shipments approximately 68 percent of the total inputs were capital inputs and 32 percent were labor inputs. The break-bulk shipments averaged 51-percent capital inputs and 49-percent labor inputs. The capital intensiveness of the van container method and the labor intensiveness of the break-bulk method are clearly differentiated.

Analysis of the accounting costs of the ocean carriers showed that terminal costs at origin and destination for the break-bulk shipments acccounted for almost 37 percent of the total costs of the marine segment of the through movements as compared with about 14 percent for the van container shipments. Refrigerated van container expenses made up a significant part of the operating costs of the containership operators. However, most of the operating expenses for the containerships were for wages, subsistence, and services of the ship's crew.

INTRODUCTION

The export market for frozen poultry meat products provides a major source of income to some segments of the U.S. poultry industry. Since the domestic demand for poultry meat products is inelastic, increased sales in the foreign markets also benefit other producers supplying the domestic markets by helping to increase the prices they receive for their products.

In recent years U.S. poultry has faced severe competition pricewise in overseas markets from subsidized competition and formidable trade barriers in the form of import levies and sanitary regulations. Countries within the European Community are also exporting subsidized poultry to many traditional U.S. poultry markets. At the same time the costs of handling, transport, documentation, and various other services included in getting the U.S. products to foreign markets have greatly increased.

In the 1960's, poultry products in many competing areas overseas increased manifold. Adoption and use of advanced technology in production and processing and comparatively low labor costs, in addition to preferential treatment in many marketing areas and payment of export subsidies, gave many foreign producers sizable competitive advantages over U.S. producers in important overseas markets. In addition to these advantages, many foreign producers had far lower handling and transport costs for moving their poultry to some important world markets because of their geographical proximity to them. Nearness to the markets and less handling and transport time required to place their products at the point of consumption also meant less risk of physical damage and exposure of the products to unfavorable environmental conditions in transit as com-

pared with the transoceanic shipments of U.S. poultry producers.

Many of the advantages of the American poultry producers resulting from economies of scale, use of advanced production and processing technology, ready access to a large quantity of feed grains and supplements, and various other factors are offset in the export market by the conditions just enumerated.

Since the costs of handling and transport of U.S. poultry to foreign markets largely determine the costs to the American producer of placing his products in those markets, they also partly determine the amount of subsidies he must have to meet foreign competition. The major determining factor is the amount of subsidies paid to competing producers in other countries by their respective governments. Therefore any improvement in handling and transport that will reduce the cost of these services for export shipments should in the long run help to improve the competitive position of the American producer in the foreign markets and help to reduce the cost of any subsidies paid to him.

The introduction and subsequent growth of containerized handling and transport for intermodal shipments to overseas destinations afforded an opportunity to reduce handling, transport time, and costs and to improve the quality of environmental protection for overseas shipments of perishable agricultural and food products. This development led to considerable interest by the poultry industry in finding out whether the new handling and transport technique could be used to improve the efficiency and reduce the costs of getting its products to overseas markets. This report presents the results of research to obtain answers to these questions. The information reported here supplements the results of research previously presented in an interim report on this research.[1]

An attempt has been made here to evaluate the physical and cost characteristics of the van container and break-bulk methods of handling and transport used in moving poultry from U.S. producers to overseas receivers. Experimental shipments were made from various points of origin in the United States to several overseas destinations. Comparisons were set up in paired shipments, i.e., one experimental shipment by van container and one control shipment by break-bulk from the same origin to the same destination at about the same time. However, since the research had to be carried out with regular commercial shipments over which the researchers had little or no control, it was not possible to keep comparisons on a strictly paired basis. Nevertheless the measures of performance for each method of handling and transport obtained in the comparisons are reasonably representative of the shipments made by each type of intermodal shipping method at the time this study was made. More important, however, such measures of physical performance as were obtained are sufficiently accurate to reflect the basic differences between the two methods in the physical movement of poultry.

The cost comparisons made in this study are intended to answer these questions: (1) How much did each type of shipping method cost the poultry owner? (2) What did it cost to produce each type of handling and transport service? (3) How were the total costs of the through intermodal movements distributed between the different handling steps and transport modes and different types of economic inputs? Total transport costs were developed to answer the first question and economic costs were calculated to answer the last two questions. Such cost comparisons not only serve to identify the differences and relative cost advantages and disadvantages of the two shipping methods but also help to spotlight the areas where improvements are needed and where innovation may yield the greatest dividends.

The cost comparisons in this report have limited application because the costs of the different inputs required to produce each type of handling and transport service vary from one area to another and from one time to another and each type of input is used in different proportions by each carrier. This is particularly true because this study was made at a time when containerized transport for transoceanic

[1] NICHOLAS, C. J., and RISSE, L. A. TRANSPORTING PACKAGED FROZEN POULTRY TO EUROPEAN MARKETS IN VAN CONTAINERS AND BREAK-BULK SHIPMENTS. U.S. Dept. Agr. ARS 52–28, 23 pp. 1968.

shipment of perishables was being developed.[2] Therefore the costs presented in this report are representative only for the particular shipments covered by the study. However, the data are considered to be sufficiently representative of the two types of service used for the transport of poultry during this period. The comparisons made in this report reflect the basic cost characteristics and differences between the two systems of handling and transport.

METHODOLOGY

Test Shipments

Six paired tests and five individual van container and break-bulk shipments of frozen poultry were made over a 3-year period. Each pair of shipments originated from the same poultry processing plant and was delivered to the same overseas receiver. One additional break-bulk test shipment and two additional van container test shipments were made from various points in the United States to several foreign countries.

Temperatures of both the break-bulk and van container shipments were obtained from recording thermometers placed in the shipping boxes (fig. 1). These thermometers were removed at the receivers' warehouses overseas.

The condition of the poultry products and the boxes was recorded at place of origin, upon arrival at embarkation port, at destination port, and at the receivers' warehouses.

Seventeen receivers of test shipments were questioned about their reaction to van container and break-bulk shipments. They also were questioned about damage, pilferage, and other problems when they imported U.S. poultry.

Development of Costs

Labor costs were based on the time required for truck and ship loading and unloading and on wages paid by poultry processors, warehouse operators, stevedore companies, and ocean carriers. Inland and ocean freight charges were obtained from bills of lading and carriers' tariffs. Forwarding, insurance, and port charges were collected from shippers and forwarders. Information on customs regulations and requirements was acquired from customs officials, forwarders, and receivers. The time required to load, transport, and unload each shipment was recorded.

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FIGURE 1.—Placing recording thermometer in poultry box when loading at poultry plant.

Transport costs for handling and moving poultry through the intermodal cargo system—from the shipper to the port of shipment, the ocean transportation, and from the port of destination to the overseas consignee—were developed from various sources. Where possible, origin documents were studied, shippers and forwarders were interviewed, and the specific experimental shipments were followed to assure the reliability of the research data.

[2] Although the data on which this publication is based were collected during 1966–69, the methodology is still valid and useful as guidelines for developing similar cost and input data in similar transport analyses.

The physical resources or capital inputs used to transport the shipment from origin to destination were identified and the economic costs were measured for the experimental test shipments by several methods depending on the information available. The economic costs of the break-bulk carriers were synthesized from information filed with the U.S. Maritime Administration. These data were summarized to make them comparable with cost data for the containerized carriers. Costs for each type of input for both types of transport operations were then classified on a capital and labor basis.

Information on the methodology for calculating economic costs for transportation is meager. The available information indicates that most past studies that attempted measurement of economic costs have not given precise results. The main reasons for such difficulties include the use of many publicly financed facilities in most transport operations and the lack of sufficient refinement in carrier financial and accounting records to enable greater accuracy in identifying and measuring the various inputs. Notwithstanding these limitations, it is still possible to obtain sufficiently accurate estimates of these costs to enable broad comparisons of the containerized and break-bulk methods of intermodal transport.

FACTORS IN EXPORTING POULTRY

Exporting poultry to overseas markets is a complex operation, requiring the services of many diverse groups in the distribution system. The effort and complications of exporting to overseas markets have been so great that some poultry shippers have made little or no effort to service export markets. The analysis of the functions in the export of poultry is reported here in order to identify, define, and describe some of the more important services and problems of moving the product to foreign markets.

Loading Shipments

The handling and truck-loading methods at the poultry processing plants were similar for both the break-bulk and the van container shipments. The poultry boxes were brought on pallets to loading docks from the shippers' cold storage facilities by forklift trucks. Boxes were then manually loaded from the pallets and handstacked in the trailers or the van containers. The operations were not highly mechanized and were predominantly manual.

Labor costs were not significantly different for loading the refrigerated van containers and the over-the-road trailers. Although the actual loading of the individual corrugated fiberboard boxes in the trailers or van containers was performed with dispatch, there was some delay in getting the palletized units of boxes from the cold storage areas to the loading dock. Delays in loading were generally caused by stamping and marking the boxes for export, inspections and stamping of boxes by U.S. Department of Agriculture graders, and sporadic deliveries of palletized units from the cold storage areas.

At the port of shipment, the individual boxes in break-bulk shipments were handled manually three times. As palletized units they received two additional handlings while being transferred from the refrigerated trailers to the refrigerated hold of the ship. The boxes were stocked on pallets when they were unloaded from the trailer and then transported to the outloading section of the pier warehouse, where they were temporarily stored. At loading time the pallets were transported by forklift truck to shipside, where they could be placed in the ship's cargo sling. Palletized units were lifted aboard the ship and lowered into the hold, where the boxes were removed from the pallets and placed on a roller conveyor for transfer to the refrigerated compartment. In the refrigerated compartment the boxes were removed from the conveyor and stacked in the ship's hold.

Upon arrival at the overseas port (fig. 2), the loading process was reversed and five more handlings were required in unloading from the ship's hold into the inland transport truck.

After the individual van container was loaded, it was sealed at the processing plant. The poultry was not handled again until the

seal was broken for customs inspection either at the border of the destination country or at the receiver's warehouse.

Labor Costs and Efficiency

Labor requirements and costs for physical handling of the poultry in the van container and break-bulk shipments in this study are shown in table 1. These data show that the costs of loading both shipments at origin and unloading them at destination varied widely. This great difference in handling costs between individual shipments was caused primarily by the large differences in man-hours required to load and unload the shipments. This, in turn, reflects the extensive differences in handling and loading methods at different processing

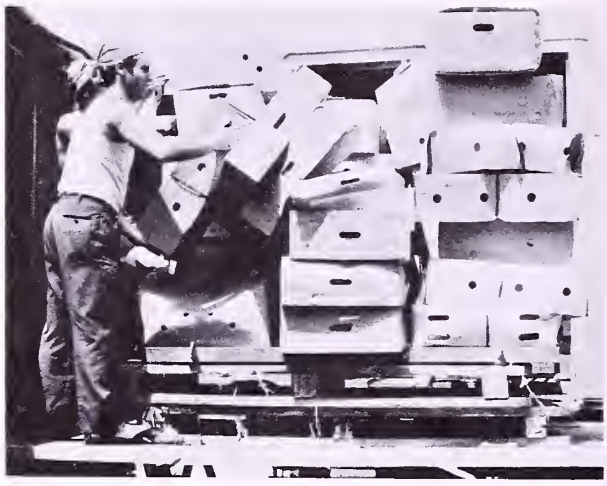

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FIGURE 2.—One of five handlings required at overseas port to unload break-bulk poultry shipment.

TABLE 1.—*Labor productivity and costs for shipping U.S. frozen poultry*

Test shipment	Weight	Shipper's plant			Embarkation port		
		Handling time	Poultry handled per man-hour	Cost per pound	Handling time	Poultry handled per man-hour	Cost per pound
	Pounds	*Man-hours*	*Pounds*	*Cents*	*Man-hours*	*Pounds*	*Cents*
1. Van container	26,969	14	1,926	0.08	1.5	17,979	0.02
2. Break-bulk	25,576	10	2,558	.05	[3] 45	568	.55
3. Van container	32,800	10.25	3,200	.04	1.5	21,867	.01
4. Break-bulk	31,478	11.5	2,737	.03	[4] 16	1,967	.14
5. Van container	30,119	10.25	2,938	.03	[5] 7.75	3,886	.05
6. Break-bulk	25,763	5.5	4,684	.04	23.75	1,085	.39
7. Van container	28,196	10.5	2,685	.09	[6] 8.75	3,222	.12
8. Break-bulk	33,872	11.5	2,945	.05	25.5	1,328	.37
9. Van container	34,560	10	3,456	.04	1.5	23,040	.03
10. Break-bulk	36,321	10.5	3,459	.04	36.75	988	.35
11. Van container	36,000	12	3,000	.05	[7] 20	1,800	.22
12. Break-bulk	28,020	5	5,604	.03	22	1,273	.22
13. Van container	34,525	10.5	3,288	.07	1.5	23,017	.04
14. Break-bulk	31,575	7.5	4,210	.03	54	584	.59
15. Van container	32,770	5.5	5,958	.03	1.5	21,847	.01
16. Break-bulk	32,000	4.26	7,512	.02	14	2,286	.14
17. Do	33,000	6	5,500	.03	28	1,142	.33
Average all tests:							
Van container	-----	10.38	----	----	5.5	----	----
Break-bulk	-----	7.97	----	----	29.44	----	----
Average	-----	9.10	3,862	.044	18.18	7,522	.211

[1] Labor productivity based on pounds of poultry handled per man-hour.

[2] Total based on weight of shipment divided by total man-hours.

[3] Based on sample number of observations of loading and unloading van containers on and off ships; crew of 18 men required on an average for 5 minutes per van container.

[4] Frequent interruptions occurred in loading and unloading operations.

plants and at the overseas receiving points. These variations in labor requirements and costs also suggest that there are considerable variations in handling efficiency between different shipping and receiving facilities.

Table 1 also shows the man-hour requirements and costs for loading and unloading the van container and break-bulk shipments to and from the ships at the embarkation and debarkation ports. Although the costs for loading and unloading the cargo are absorbed by the ocean carriers, they are in the long run reflected in the ocean freight rates charged by the carriers. Loading and unloading at the ports also showed wide variations in man-hour requirements and labor costs. The differences partly reflect the divergence in efficiency of the loading and unloading methods. They also indicate the disparity in the labor requirements and handling costs between the van container and break-bulk systems.

Cost per pound for loading the poultry at the embarkation port ranged from 1 cent to 59 cents, whereas the cost of unloading ranged from 1 cent to 32 cents. Costs for loading the poultry varied with the location and the circumstances under which the product was loaded. However, costs for loading the break-bulk shipments were far higher than for the van container shipments, ranging from 0.14 cent per pound to as high as 59 cents. For two of the break-bulk shipments the labor costs for loading the poultry onto the ship were from 10 to 18 times the ocean freight rate and several times the shipside value of the product.

to overseas markets by van container and break-bulk systems, 1966–69 [1]

Debarkation port			Destination			Total		
Handling time	Poultry handled per man-hour	Cost per pound	Handling time	Poultry handled per man-hour	Cost per pound	Handling time	Poultry handled per man-hour [2]	Cost per pound
Man-hours	*Pounds*	*Cents*	*Man-hours*	*Pounds*	*Cents*	*Man-hours*	*Pounds*	*Cents*
1.5	17,979	0.02	13.5	1,998	0.05	30.5	884	0.17
[3] 114	224	.32	16	1,598	.04	185	138	.96
1.5	21,867	.01	10	3,280	.02	23.25	1,411	.08
67	470	.25	14	2,248	.07	108.5	290	.49
1.5	20,079	.02	12	2,510	.03	31.5	956	.12
99	260	.24	15	1,718	.04	143.25	180	.71
1.5	18,797	.01	3.6	7,832	.04	24.35	1,158	.26
40	846	.17	7	4,838	.01	84	403	.60
1.5	23,040	.03	10	3,456	.02	23	1,503	.12
34	1,068	.13	8	4,540	.01	89.25	407	.53
2	18,000	.08	6	6,000	.08	40	900	.43
[3] 36	778	.08	7	4,003	.08	70	400	.41
1.5	23,017	.04	4.5	7,672	.05	18	1,918	.20
36	877	.19	10.5	3,007	.05	108	292	.86
1.5	21,847	.02	7	4,681	.01	15.5	2,114	.07
19	1,684	.01	3.75	8,533	.04	41.01	780	.21
[4] 54	611	.03	10	3,300	.06	98	337	.45
1.56	-----	----	8.32	----	----	---	----	----
55.44	-----	----	10.14	----	----	---	----	----
30.08	10,084	.097	9.28	4,189	.04	66.7	828	.39

[5] Poultry transferred from piggyback trailer (chassis attached) to van container at embarkation port; 6¼ man-hours required to load poultry in van container and 1½ man-hours to load van container on ship.

[6] Unloading delayed because of rain.

[7] Shipment by refrigerated railcar to port and transported in van container.

[8] Container loaded at port from over-the-road trailer and then loaded on containership.

[9] Shipment unloaded offshore onto lighter.

Tons of poultry handled per man-hour at the embarkation port, a common measure of cargo handling efficiency, averaged only 0.57 for loading all break-bulk shipments as compared with 6.63 for the van container shipments. The greater efficiency in the rate of labor utilization for the van container system over the break-bulk system was even more apparent in unloading the ships at overseas ports. At these ports the van containers averaged 9.4 tons per man-hour as compared with only 0.34 ton per man-hour for the break-bulk shipments.

Unloading Shipments

Unloading charges at the overseas ports were absorbed by the ocean carrier for both break-bulk and containerized shipments. However, the costs were lower than comparable charges at U.S. ports because of the lower prevailing wage rates. The overseas ports were highly mechanized, but the unloading operations of the conventional or break-bulk shipments were predominantly manual, as the individual packages were handled three or four times. All the overseas ports through which the test shipments were routed had "free port" [3] facilities available for transit or storage. Shipments 12 and 13 were stored by the receiver at the free port facilities while awaiting a favorable price change before final sale. The American van container carriers had established modern and highly mechanized facilities at the overseas ports of Bremen, Rotterdam, and Tokyo, and the transfer from the containership to the inland delivery vehicle was performed rapidly and at low cost.

The van container was removed from its chassis and loaded on the containership at the port of shipment and was unloaded at the overseas port and placed on a waiting trailer chassis by either a ship-based gantry crane or a track-mounted dockside crane. The gantry-type container crane is electrically operated by one operator, has a lift capacity of 27.5 tons, and operates at various heights, ranging from 80 to 206 feet.

[3] "Free port" facilities are where goods that have not passed through customs may be temporarily stored in bond while awaiting disposition, diversion, or sale by the owner.

Product Protection

All but one of the break-bulk shipments were carried in refrigerated compartments located in the upper and lower between-deck spaces of dry-cargo ships. The other break-bulk shipment was moved on a small (1,300-ton) totally refrigerated, chartered cargo ship. The refrigerated compartments were cooled by air circulated over refrigeration coils in the ceiling. The cooled air was discharged from blower outlets above the load and moved down the sidewalls to the rear of the load to enter channels under the floor racks before it returned to the evaporator coils by circulating upward through the load.

All the refrigerated van containers were of conventional design, with 3 inches of polyurethane insulation and with mechanical refrigerating units recessed into the front ends. The refrigerating units had cooling capacities of 18,000 Btu at 0° F (7 tons) and temperatures of −15° to +60°.

Most of the refrigerated van containers used in these shipping tests were of similar construction, with inside dimensions of 7 feet 3 inches high, 7 feet 4 inches wide, and 32 feet 1 inch long, with an interior of 1,705 cubic feet. However, because of the space occupied by the refrigeration unit and by the ceiling air duct, which extended more than three-fourths the length of the van container, the usable loading area was only 1,450 cubic feet.[4]

The electrically driven refrigeration units of the van containers were powered from propane gas motor-driven generators or 440-volt electric current introduced from outside the van. Propane motor-driven generators were used as power sources when the vans were transported over the road. During ocean transit, shipboard generators served as power sources. While the vans were on board ship, the inside air temperatures and the functioning of the refrigeration units were checked every 4 hours.

Frozen poultry should be maintained between 0° and −20° F.[5]

[4] SEA-LAND SERVICE, INC. REEFER OPERATIONS MANUAL. 77 pp. Elizabeth, N.J. 1965. (See Sect. 6, p. A–1.)

[5] AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR CONDITIONING ENGINEERS. ASHRAE GUIDE AND DATA BOOK. 1023 pp., illus. New York. 1966–67. (See p. 640.)

The variations in the break-bulk temperatures from 9° to 24° F, as shown in figure 3 for test shipment 2, indicate one of the uncertainties of the break-bulk mode of shipping due to the commingling in the ship's refrigerated hold of various products with different temperature requirements. As a result, the air temperatures in the hold did not meet the requirements of some of the commodities stowed there.

Exposure of the poultry products in the break-bulk shipments at port transfer points was a serious problem. The poultry in some of the test shipments was temporarily stored in a covered pier area at very high outside air temperatures while waiting to be loaded aboard ship.

The air temperatures in the van containers averaged −9° F and maintained the cargo at desirable temperatures from the time it was loaded at the shipper's plant until it was unloaded at the receiver's warehouse. For example, in one of the test shipments at loading, the temperature of the product in the van container shipment was 0°. During loading the air temperature in the van container was about 30°. Upon arrival, after 18 days in transit, the temperature in the containerized load ranged from −10° to −15°. Temperatures were below 0° during the entire trip. In figure 3 are shown the differences between the average air temperatures in the van container and the break-bulk shipments.

The air temperatures in the break-bulk shipments, which averaged +14° F, varied much more than those in the van containers for test shipments 9–10 (fig. 3). In one of the test shipments the temperature of the product was −3° at loading. Over-the-road trailers when loading were not precooled and the air temperatures ranged from 25° to 43°. During the unloading from trailers at the New York Port and because of a delay in loading aboard ship, the air temperature rose inside the boxes of turkeys loaded on the pier and many of the turkeys began to thaw. About 3 days were required to cool the load in the refrigerated hold to 17°–19°.

Inland Transport to U.S. Ports

Fourteen out of the total seventeen test shipments were transported from the shipper's plant to the port by truck. Rail service was not on a rate-competitive basis with trucks for moving the empty van container from the port to the shipper's plant and the loaded container from the plant to the port. The preponderance of truck shipments was due to more favorable rates and the expeditious service offered by the truckers. All the participating truckers were "exempt carriers," [6] and their charges were always dependent on the prevailing supply of and the demand for their services.

The inauguration of containership service from Baltimore, Md., Norfolk, Va., and Charleston, S.C., helped to reduce the transit time to one-half day from the shipper's plant to the port as shown in test shipments 3 and 4 (table 2). Because of the lack of containership service from the east coast of the United States to the Orient, test shipment 11 had to be hauled by refrigerated trailer to the west coast, where the frozen poultry was then transferred to a van container for loading aboard a containership. The acute shortage of refrigerated van containers on the west coast at the time of this study prevented the carrier from allowing them to leave the drayage area of the port. Although there was no great difference in inland transport charges between the van container and break-bulk shipments, the problem of delivering loaded van containers and returning empty ones to the port still remains.

Ocean Transport

Ocean transport of frozen poultry to overseas markets varied because of available service and cost considerations. Before the development of containerization, most of the overseas poultry shipments were transported by foreign flag carriers. Most foreign flagship lines were nonconference carriers, i.e., they belonged to no freight rate conference. The rates of these nonconference carriers were from

[6] Truck owner-operators with no certification from the Interstate Commerce Commission, hauling agricultural products, were mainly exempt from ICC regulation of rates and service.

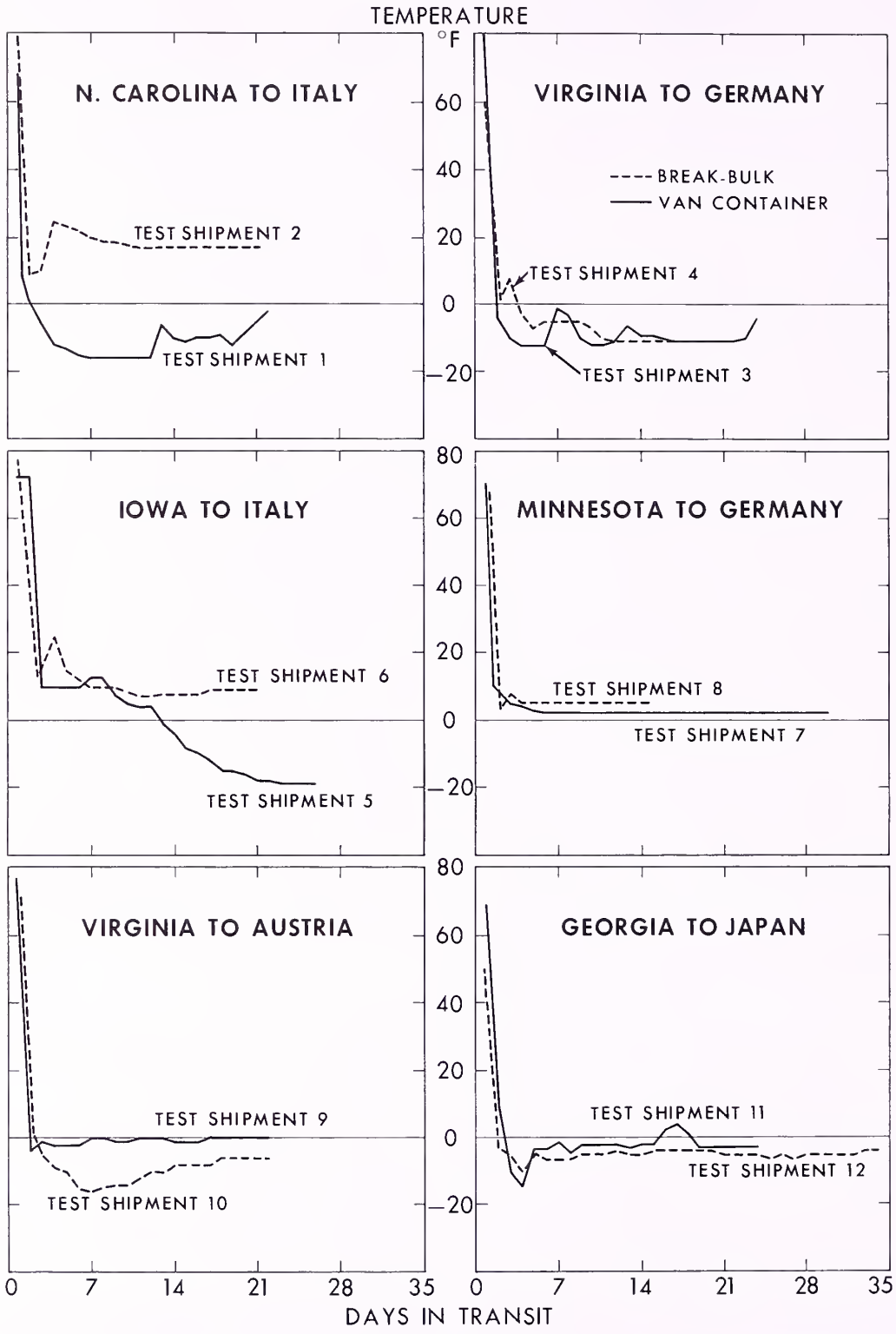


FIGURE 3.—Daily average air temperatures (°F) inside poultry boxes for various paired break-bulk and van container test shipments.

TABLE 2.—*Transit times for test shipments of frozen poultry to overseas markets by van container and break-bulk systems, 1966–69*

Test shipment	Origin	Destination	U.S. inland transport to port		At embarkation port		Ocean transport		At debarkation port		Overseas inland transport to destination		Total transit time
			Duration	Amount of total transit time	Duration	Amount of total transit time	Duration	Amount of total transit time	Duration	Amount of total transit time	Duration	Amount of total transit time	
			Days	*Percent*	*Days*	*Percent*	*Days*	*Percent*	*Days*	*Percent*	*Days*	*Percent*	*Days*
1. Van container	North Carolina	Italy	1	1	1	4	[1] 17	77	2	9	[2] 2	9	23
2. Break-bulk	do	do	3	15	1	5	13	65	1	5	[3] 2	10	20
3. Van container	Virginia	Germany	.5	2	3	18	12	70	1	5	1	5	17.5
4. Break-bulk	do	do	.5	1	[4] 7	32	13	59	1	4	1	4	22.5
5. Van container	Iowa	Italy	[5] 6	22	1	4	[6] 15	58	1	4	[2] 3	12	26
6. Break-bulk	do	do	2	10	1	5	13	61	[7] 4	19	1	5	21
7. Van container	Minnesota	Germany	[5] 4	14	7	22	10	32	5	16	5	16	32
8. Break-bulk	do	do	2	13	1	7	10	66	1	7	1	7	15
9. Van container	Virginia	Austria	[5] 6	27	1	4	10	43	1	4	5	22	23
10. Break-bulk	do	do	1	4	1	4	[6] 15	69	3	14	2	9	22
11. Van container	Georgia	Japan	3	12	3	12	17	68	1	4	1	4	25
12. Break-bulk	do	do	2	5	1	3	32	84	2	5	1	3	38
13. Van container	Nebraska	Germany	3	10	14	48	10	34	1	4	1	3	29
14. Break-bulk	Virginia	Switzerland	2	10	1	5	[6] 13	65	2	10	2	10	20
15. Van container	Nebraska	Germany	4	22	1	5	12	63	1	5	1	5	19
16. Break-bulk	Georgia	Greece	1	4	2	7	18	72	3	13	1	4	25
17. Do	Virginia	Hong-Kong	2	5	1	2	39	89	1	2	1	2	44

[1] Ship delayed 3 days by mechanical difficulties.
[2] Highway transport from Rotterdam to Milan.
[3] Rail transport from Genoa to Milan.
[4] Ship detained at port awaiting cargo.
[5] Trailer piggybacked to port, load transferred to container van.
[6] Delay because of rough seas.
[7] 3-day delay because of rain.

20 to 25 percent below the rates of the American flag carriers. All the break-bulk shipments studied were carried by foreign flag, nonconference lines. Most break-bulk shipments sustained considerable pilferage and product and box damage. Delays in transit were common, and the product was often exposed to high outside temperatures during transfer at unloading and loading.

All the van container shipments were made on American flagships because the American carriers inaugurated the container service to Europe and the Far East. There was very little competition from foreign flag carriers when this study was made. Although the rates for van container service were higher than for the nonconference break-bulk carriers, this was in part compensated for by the lack of pilferage and greatly reduced loss and damage. In addition, some container carriers offered a rate discount on door-to-door service, where the shipper loaded the van container at his plant and the receiver unloaded the van container at his warehouse.

Overseas Inland Transport

All the overseas inland deliveries were made by truck. Although transit time for delivery was generally very good, the costs for van container deliveries were high because of the problem of returning the empty van container to the port. If delivery was within the port area, the ocean carrier absorbed these charges.

Few refrigerated trucks were available in European cities for local delivery of break-bulk shipments and usually delivery was made in nonrefrigerated vehicles. Test shipments 2 and 6 were delivered in warm weather and the product sustained some thawing until it was placed in the receiver's cold storage warehouse.

Transit Time

The transit times for the experimental shipments in table 2 show no important differences between the break-bulk and the van container shipments. Seven of the shipments were made during November and three of these were delayed by storms at sea. Another reason for the extended transit time was due to poor coordination in transport schedules between the inland and the ocean carriers.

Two of the break-bulk shipments were transported on fast (20 knots per hour) ships, although one was detained for 2 days because it stopped to discharge cargo at a preceding port. One break-bulk shipment to Italy was delayed 2 days by discharge of cargo in Barcelona, Spain, and still another—to Greece—was transported by a small (1,300 tons), refrigerated, chartered ship that averaged only 14 knots an hour. There was a 3-day delay in unloading another break-bulk shipment in Italy.

Most of this study was conducted while van container service to Europe was being established. Equipment shortages, inclement weather, and U.S. Defense Department priorities at times severely handicapped the ocean carrier in providing the most expeditious van container service. Van container shipments 7 and 13 were unusually delayed at the port of embarkation because the ocean carrier was unable to provide refrigerated space aboard its containership. The relatively long transport time for some break-bulk ships to deliver shipments to destination ports was due to stopping at intermediate ports of call to pick up other cargo before making the ocean crossing and to discharge it after the crossing.

The containerships used for the container service in the North Atlantic during 1966–69 were mostly converted tankers or general cargo ships with 14- to 16-knot crossing speed. Since then, however, some of that equipment has been replaced by newer, faster (20 knots) containerships, which cross the Atlantic in 6 days instead of 10 required by the older, slower vessels.

Load Density [7]

To make efficient use of the space and weight capacities of the van containers used in the tests, load densities of 21.6 pounds per cubic foot were required. The degree to which frozen poultry is adaptable to containerization is large-

[7] Ratio of load mass to volume of available loading space. Term generally used to denote degree of utilization of the cargo capacity of a transport vehicle by the cargo.

ly dependent on its load density, or load factor, which represents the average weight loaded in an individual container in relation to the container's interior cube. Matching the cube of the van container with the weight of the commodity hauled also serves to determine the optimum size of the container. The load density per cubic foot was greater than required for two shipments, about 21 pounds for one shipment, and less than 21 pounds for two shipments (table 3).

Freight Forwarder

The primary function of the forwarder was to expedite the movement of the cargo from the shipper's plant to the port of embarkation. As soon as the forwarder was contacted by the shipper, he began the difficult job of preparing the necessary documentation, provided for the inland transportation from the shipper's plant to the embarkation port, booked cargo space with an ocean carrier, and arranged for U.S. Customs clearance for the shipment.

U.S. forwarders' fees for the experimental shipments varied from $16 for the earliest shipments to $17.50 for the last group. The overseas forwarder provided for the necessary movement through customs and for transportation from the port to the receiver's warehouse. His fee was generally 1 percent of the charges shown on the ocean bill of lading.

Insurance

Insurance rates charged for the experimental shipments were the same for both the breakbulk and the van container, averaging $0.0025, or one-fourth cent per pound. The insurance coverage provided only for loss or damage to the product either in the refrigerated locker on a ship or in a van container because of malfunctioning or breakdown of the refrigeration unit and then only when the product was bought on a C.I.F. (cargo, insurance, freight) basis. When the product was bought on a C.F. (cargo and freight) basis, insurance coverage was provided by the receiver. Insurance coverage for the cargo when moving inland was provided for by the inland carrier.

Insurance to cover pilferage, shortages, or physical damage to the cargo from port to port was provided by the ocean carrier or insurance underwriters.

Documentation Requirements and Costs

Documentation requirements have for some time been a great burden in moving frozen poultry to overseas markets. Documentation was continuously needed from the time the sale of the export was concluded until actual movement of the poultry from the shipper's facility to the receiver's premises was complete. Most of the shipping documents were prepared by the forwarders and the remainder by the shippers, receivers, and carriers. In addition to the work and time consumed in preparing the documents required for each shipment, more time and effort were spent in continuously checking at the various physical interchanges of the shipment between carriers

TABLE 3.—*Load densities of test shipments of frozen turkeys in van containers*

Contents per box	Outside box dimensions	Boxes used per load	Gross weight of load [1]	Load density [2]
	Inches	*Number*	*Pounds*	*Pounds per cubic foot*
Turkey parts	25¾ × 13 × 7	1,000	33,000	22.8
Turkeys and weight of each:				
6, 6–8 lb	26 × 21½ × 7	700	32,800	22.6
6, 8–10 lb	26 × 21½ × 7	718	30,970	21.4
2, 20–24 lb	19 × 16½ × 9½	633	26,969	18.6
2, 24–26 lb	19 × 16½ × 9½	664	30,119	20.8

[1] Includes poultry weight in boxes.

[2] Gross weight of shipment divided by 1,450 cu ft, which is usable van container capacity.

and in customs clearance. Although the TIR Convention [8] helped to break documentation impasse on the movement of van containers in Europe, the break-bulk test shipments were subject to delays in preparing innumerable forms in countless copies. Table 4 shows some of the importing countries to which the shipments were made and the documentation or paperwork required by each.

Most of the documentation was arranged for by the import broker and the expense was borne by the consignee or receiver. The use of the USDA Forms PY 506, Export Certificate (on product wholesomeness), and PY 224, Grading Certificate, was helpful to the importers in clearing the shipments through the customs and health and sanitation inspectors of the importing countries. Not only was considerable expense involved in preparing the documentation, but clearing the papers through customs delayed the movement of the shipments. For instance, German Customs required from 2 to 6 hours to clear a shipment, whereas Italian Customs sometimes required 2 to 3 days. Containerization has helped to set a definite trend toward modifying national restrictions and reducing delays at customs. Furthermore, the documentation requirements of the various countries were noticeably different. The Free Port of Hong Kong required only 2 forms, whereas Italian Customs required 10.

Export documentation requirements also increased transit time and shipping costs. In addition to the USDA Forms PY 506 and PY 224, copies of the bill of lading, invoice, insurance certificate, ocean bill of lading, and the forwarder's bill of lading, the Export Declaration Form 7525–U, were required. Although the costs of documentation are borne by the consignee, they are ultimately passed on to the consumer of the product. They must therefore be considered a part of the total expense of moving the cargo to foreign markets.

Assigning a cost to the time and effort required by documentation was difficult. However, one researcher has estimated the average cost for documentation per export shipment as $163.[9] This charge was broken down as follows:

Exporter	$43 per order processed
Domestic carrier	3 per waybill
Freight forwarder	25 per shipment
International carrier	10 per bill of lading
Opening bank	27 per line charge
Paying bank	27 per line charge
Insurance underwriter	3 per certificate
Customhouse broker	25 per shipment
Total	$163

The van container shipments had few difficulties in customs clearance at the ports or at border crossings in transit. The two van container shipments to Italy entered through the port of Rotterdam, where there was no delay, and the only documentation papers required were (1) a certificate of nonmanipulation, (2) a customs declaration, and (3) a TIR carnet voucher, which is a declaration of import presented by the receiver's forwarder. The van containers moved unimpeded from the Netherlands through West Germany and Austria to the Italian border, where the container seal was broken by customs officials and the contents of one of the boxes were examined briefly. On subsequent shipments the customs inspection, by previous arrangement, was performed at the receiver's warehouse where import duties were paid.

The following documentation was required for this final clearance before release of the shipment to the receivers:

(1) Certificate of nonmanipulation
(2) Copy of the shipment invoice
(3) USDA Form PY 506, Export Certificate
(4) Original bill of lading
(5) Certificate of origin
(6) USDA PY 224, Grading Certificate
(7) Bank payment order

Three of the van container shipments to Germany were unloaded at Bremen and moved to the receiver's warehouse in Hamburg with minimum delay. The receiver's import forwarders obtained immediate release of the contain-

[8] The Customs Convention in the International Transportation of Goods by Road Vehicles Formulated by the United Nations Economic Commission for Europe on January 7, 1960, Geneva, Switzerland.

[9] A. T. Kearney & Company for National Committee on International Trade Documentation. score line traffic executive newsletter. V. 1, No. 4. Jan. 1968.

TABLE 4.—*Import documents required for experimental shipments of poultry by countries, 1966–69*

Document	Germany	Greece	Italy	Austria [1]	Netherlands	Hong Kong	Japan
Declaration of transit [2]	X		X	X			
Invoice	X	X	X	X	X		X
Bill of lading	X	X	X	X	X		X
USDA Export (health) Certificate (PY 506)	X	X	X	X	X	X	X
Certificate of insurance	X						
Certificate of nonmanipulation [3]	X		X				
Bill of sale	X		X				
Certificate of origin	X	X	X	X	X		X
Pro forma invoice		X					
USDA Grading Certificate (PY 224)		X	X				X
Customs clearance permit		X					
Export Declaration Form 7525-U			X				
Dock receipt			X				
Import license		X		X	X	X	X
Customs entry form		X		X	X		

[1] Entry through port of Rotterdam.
[2] For shipment where port of entry is not located in country of destination.
[3] Required by Italian Customs for import of all containerized traffic.

ers with the presentation of the invoice and certificate of origin. The forwarders also arranged to have the customs inspection performed and the duty paid at the receiver's warehouse. In addition to payment of the duty, the following documents were required for customs clearance:

(1) Bill of lading
(2) USDA Form PY 506, Export Certificate
(3) Certificate of origin
(4) Bill of sale

When the shipper received a firm commitment from his customer in Germany, he notified his forwarder to make all the necessary shipping arrangements.

The forwarder, upon notification, made the booking arrangements with the ocean carrier, contacted the inland carrier to make the pickup, and proceeded with all the other necessary arrangements, including the documentation and billing information. The carrier then issued a booking number for this shipment. Upon receipt of the shipping information, the forwarder prepared a U.S. Export Declaration Form 7525–U. He sent this form to the U.S. Customhouse, where it was numbered and validated. The purpose of this form was to provide verification that no export license was required for this shipment. The forwarder also prepared an ocean bill of lading, a dock receipt, and a certificate of origin. He then issued an insurance binder on the shipment, awaiting the completed bill of lading from the shipper. Upon receipt of the shipper's bill of lading, the forwarder completed the ocean bill of lading, issued the insurance policy, and sent three originals and three copies of the bill of lading along with two certificates of origin and two insurance certificates to the importer in West Germany. The shipper received three copies of the ocean bill of lading, one copy of the insurance certificate, and two copies of the bill of charges. The forwarder also provided the ocean carrier with three copies of the ocean bill of lading.

The van container shipments fared much better than the break-bulk shipments in documentation requirements and in moving through customs. All the countries (Germany, Netherlands, Belgium, France, Austria, Switzerland, Italy) through which the van container shipments moved were members of the 1959 Customs Container Convention, which created the TIR carnet (Transportation International Routier).[10]

[10] The United States has since become a party to the Customs Container Convention, and the use of the TIR carnet forms for clearance of export shipment through U.S. Customs was effective on July 1, 1971.

The TIR carnet, a customs form, was used for all the container shipments and allowed temporary duty-free entry of containers for a period not to exceed 3 months. All that was required of the carriers handling the loaded containers was that they provide a copy of the carnet to the appropriate authority at each border crossing. The carnet contained information such as on a manifest and was a formal guarantee of the carrier to pay any duties, fines, or penalties that might be assessed by customs authorities for the privileges granted by the convention. When the shipment crossed a single frontier involving two customs administrations, a six-voucher carnet was used. A 14-voucher carnet was used if the shipment crossed more than one frontier.

The TIR carnet proved most valuable in two specific situations. One was when the poultry shipment moving by truck passed a frontier customs port en route to a customhouse at an unload destination in the same country. In this case, customs inspection took place at the unload point rather than at the frontier. The other situation was when the poultry shipment moving by truck passed through several countries en route to its destination.

Although specific documentation costs are difficult to measure, an estimate of these costs can be drawn from a recent study, which revealed that on the basis of correct shipping volumes, total documentation costs represented 7½ percent of the value of the total U.S. export and import shipments.[11]

Packaging

All shipping containers used for the frozen poultry products in this study were made of corrugated fiberboard. Most of the boxes were of 275-pound test weight corrugated board, whereas a few of the smaller containers for chicken parts were of 250-pound test board.[12] All the boxes for whole chickens and whole turkeys and most of the boxes for chicken and turkey parts were of the full-telescope type and only a few of the smaller boxes for chicken parts were of the RSC (regular slotted container) type. The joints and top and bottom flaps on all containers were fastened with metal staples.

Container Strapping.—Since all boxes used, particularly those of the full-telescope design, were easily opened, they were banded with lightweight metal straps to discourage pilferage of the contents during handling when the shipments were transferred from one mode of transport to another. Also, such banding helped prevent spillage of the contents of many boxes in the break-bulk shipments during the rough handling to which they were subjected in transit. However, since the same boxes shipped by van container were not exposed to pilferage and numerous rehandlings, the banding was not used on the different size boxes in most of the van container shipments. A check of the outturns of the van container shipments when they were unloaded at their destinations showed no damage or pilferage of either the banded or the unbanded boxes. The results suggested that no strapping was needed on the boxes when they were shipped by van containers.

To determine the potential savings that might be realized by eliminating the strapping on the boxes, a study was made to measure the costs of the labor and material used for this purpose at one plant in Virginia in 1966. Both single and double straps were used on the same type and size of box. The cost data developed in this phase of the study are shown in table 5.

To determine from the data in table 5 the potential savings in the cost of labor and material by eliminating one or both straps, it is necessary to subtract 0.39 cent from the total cost per box (last line of table). This must be done because there would be one movement of the pallet loads of boxes direct from the cold storage room to the loading dock when no strapping was used on the boxes. The potential savings in the strapping operation at the one plant in which the study was made were 2.36 cents per box by eliminating one strap and 2.77 cents per box by eliminating two straps, not including supervision and equipment costs.

Total savings per van container shipment

[11] National Committee on International Trade Documentation and U.S. Department of Transportation. paperwork or profits in international trade. 144 pp. New York. 1971.

[12] Bursting strength of fiberboard in pounds per square inch determined by Cady or Mullen test.

TABLE 5.—*Labor requirements and labor and material costs [1] in applying metal straps to fiberboard shipping boxes [2] at a Virginia plant, 1966*

Cost item	Applying 1 metal strap		Applying 2 metal straps	
	Labor	Cost	Labor	Cost
	Man-minutes	*Cents*	*Man-minutes*	*Cents*
Move pallets from storage	0.117	0.39	0.117	0.39
Place boxes on conveyor	.235	.78	.235	.78
Operate semiautomatic strapping machine	.117	.39	.235	.78
Remove boxes from conveyor and place on pallets	.235	.78	.235	.78
Move pallets to storage or loading dock	.117	.39	.117	.39
Total labor requirements and cost per box	.821	2.73	.939	3.12
Strapping materials cost per box [3]	----	.02	----	.04
Total cost per box	----	2.75	----	3.16

[1] Does not include cost of equipment, supervision, insurance, taxes, and other overhead. Includes 15-percent allowance for fatigue and personal time. Labor costs are calculated at average wage rate of $2 per hour.

[2] Full-telescope boxes with inside dimensions of 24½ by 19½ by 7 inches.

[3] Includes 15-percent allowance for strap waste.

by eliminating the strapping vary with the number of boxes per load. As shown in table 3, the number of boxes in the load varied from as few as 633 boxes containing two small whole turkeys to as many as 1,000 boxes of turkey parts. However, for whole turkey boxes of the size covered by this study, the potential savings for one van load would be $16.52 by eliminating one strap and $19.39 by eliminating two straps.

Container Strength.—Since shipment by van container significantly reduced the number of handlings of the individual boxes, it was also observed that the corrugated fiberboard boxes were subjected to fewer handling hazards and therefore sustained little or no damage. These observations suggested that somewhat less expensive boxes of lighter test weight corrugated fiberboard should be adequate for van container shipments. To test this hypothesis, the performance of boxes made of three different test weights of corrugated board was compared.

At the time of this study the container commonly used for shipping 7- to 9-pound whole turkeys by break-bulk transport was a full-telescope, corrugated fiberboard box of 275-pound test board. Since it was in fairly wide use for shipping turkeys to overseas markets, a shipping test was made on this box in which all conditions were the same, except that equal numbers of the box were fabricated from 200-, 250-, and 275-pound test board. The inside dimensions were 24½ by 19½ by 7 inches. The interior was divided into three compartments by corrugated fiberboard partitions. Each compartment was packed with two whole turkeys, each enclosed in a polyethylene film bag.

Before shipment each box was usually banded with two ⅜-inch-wide steel straps. Approximately 10 feet of strapping were required when two straps were used and 6½ feet when one strap was used to band the long dimension of the box. Each strap was tensioned and sealed separately.

The boxes made of the three different test strength corrugated board were all packed with whole turkeys in polyethylene film bags in the same processing plant, handled by the same workers with the same equipment, and loaded in the same van container for shipment to Germany. Each box of each type of board was carefully inspected during unloading of the shipment at destination.

The performance of the three types of boxes was evaluated on visible failure, physical damage to the boxes themselves, and protection of their contents. The van container load was received at its destination in good condition. There was no visible evidence of box failure in the load. Except for some normal cutting of the fiberboard by the steel strapping, none of the boxes were damaged.

The amount of damage to the polyethylene film bags on the whole turkey carcasses in each of three lots of boxes was as follows:

Test box (lb)	*Damage (percent)*	
	Slight	*Severe*
275	14.8	0.9
250	15.7	0
200	17.6	0

The damage to the bags was caused by the sharp points on the tips of the turkey wings and therefore did not indicate the adequacy of the box.

These results suggest that boxes of both 200- and 250-pound test corrugated board should be adequate for van container shipments. However, more commercial experience with the lighter test strength boxes would be necessary to establish more firmly the feasibility of this alternative packaging than was done in this limited experiment.

The cost of the boxes and strapping used in this comparison is shown in table 6. The savings vary with the type of box and the amount of strapping used. The savings on the 250-pound test box over the 275-pound test box was 2 cents per box, whereas the savings on the 200-pound test box over the 275-pound test box was 3.5 cents. Potential savings on a van container load of 700 boxes would amount to $14 and $24.50 for the 250- and 200-pound test board boxes, respectively.

The greatest potential savings could be realized by using 200-pound test board boxes with no strapping in place of 275-pound test board with two straps. This would amount to 6.7 cents per box, or $46.90 for a van container load of 700 boxes.

Container Stenciling.—Since most break-bulk shipments of frozen poultry consist of a large number of boxes, frequently as many as several hundred thousand, the shipments are made up of many lots of poultry consigned to various receivers in different overseas markets. To maintain the identity of each lot of boxes in the refrigerated hold of the ship and in handling and transfer operations, each box is stenciled with its lot number and other identifying information. However, since the van container shipments are moved directly from one shipper to one receiver and each shipment consists of a single lot, no stenciling is necessary. Although the elimination of stenciling represents another savings in the cost of preparing the boxes for shipment when van container transportation is used, no time studies to determine the cost of stenciling were made. Therefore there is no basis for estimating the potential economy from eliminating this step in preparing the boxes for shipment.

TABLE 6.—*Labor and material costs of fiberboard poultry boxes without and with straps and potential savings by eliminating 1 or both straps and by using lighter strength materials, 1966*

Container [1]	Cost per box and strapping	Savings [2]
	Cents	*Cents*
275-lb box:		
No strap	42	3.2
1 strap	44.8	.4
2 straps	45.2	---
250-lb box:		
No strap	40	5.2
1 strap	42.8	2.4
2 straps	43.2	2
200-lb box:		
No strap	38.5	6.7
1 strap	41.3	3.9
2 straps	41.7	3.5

[1] Boxes constructed of indicated test strength corrugated board.

[2] Difference between cost of experimental boxes with 1 or no straps and cost of 275-lb test box with 2 straps.

Loss and Damage

Only two of the break-bulk shipments arrived at destination in good condition. The others suffered a considerable amount of box damage. They were in disorder and many of them were partly crushed. Despite the box damage, the product was generally in good condition.

Break-bulk shipments were highly suscep-

tible to pilferage when they were handled at the ports or transfer points. Damaged cartons or boxes in the ship's hold or on the pier were frequently pilfered before they were removed. Owing to the type of pilfering when one or more birds were removed from occasional boxes, researchers were unable to record accurately the exact amount of pilferage. Because of this situation, shippers and receivers were interviewed to obtain information on this problem, but none of them maintained records on pilferage losses. Allowances for losses from pilferage of small quantities of the product were always included in the bid price submitted by the buyer. Because the shippers and receivers absorb small pilferage losses, no records were maintained on them.

Damage to the product was evident whenever it was handled at the plants, at the ports (figs. 4 and 5), or in the holds of the ships. The greatest damage to the cargo occurred at the ports in transferring the shipments from the over-the-road vehicles to the docks to the refrigerated holds of the ships. The same situation occurred at the overseas ports when the shipments were discharged and loaded on the delivery vehicles (figs. 6 and 7). Additional box damage was sustained in two of the shipments when they were not properly stacked and secured after a discharge of cargo at a preceding port.

The arrival condition of the boxes and their contents in the van container shipments was excellent. There was no shifting of boxes in transit and the stacking patterns remained intact (figs. 8 and 9).

PN–3914

FIGURE 4.—Rough manual handling of fiberboard boxes of poultry during unloading from trailer and reloading aboard break-bulk ship at southeastern U.S. port.

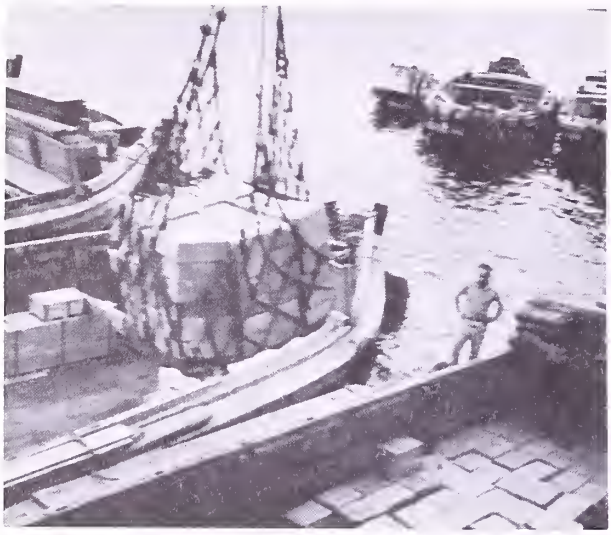
PN–3915

FIGURE 5.—Checkers at pier in Rotterdam verifying pilferage of poultry from shipment recently unloaded from break-bulk ship.

PN–3916

FIGURE 6.—Damaged cartons being unloaded from refrigerated hold of break-bulk ship in Port of Hong Kong.

Container cranes and other container handling equipment facilitated the movement and transfer of the van containers through the ports both in the United States and overseas (figs. 10 and 11).



PN–3917

FIGURE 7.—Cartons being damaged during unloading from break-bulk ship into barge by cargo sling in Tokyo Bay.

PN–3918

FIGURE 8.—Unloading of van container shipment of frozen poultry in Tokyo, Japan, in perfect arrival condition.

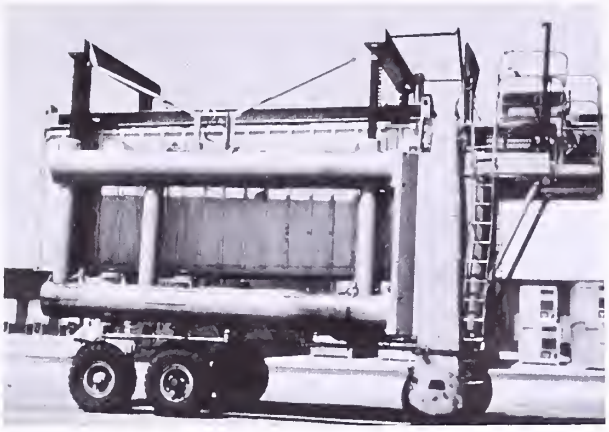
PN–3919

FIGURE 9.—Good arrival condition of van container shipment of frozen poultry, which is checked by receiver during unloading in Milan, Italy.

Loss and damage in the van container shipments were negligible. However, they were much higher in the break-bulk test shipments. Researchers were not able to record the exact amount of loss and damage because unloading was done at several different hatch locations at the same time. Inquiry by the researchers of both shippers and overseas receivers of poultry disclosed that their estimates of the amount of loss and damage in overseas break-bulk shipments of poultry ranged from one-fourth to one-half percent of the invoice value of the shipment.

Pilferage was the principal cause of loss in the break-bulk shipments. Unless the poultry was adequately boxed and strapped, pilferage in the port areas was rampant (fig. 5). Researchers observed dock workers deliberately spilling contents of the boxes to simplify pilferage. Even when the boxes were adequately strapped, pilferage was evident. Furthermore, it was very widespread in the port areas, both in the United States and overseas, and very little effort was made to combat or prevent it. In most domestic and overseas ports pilferage appeared to be a recognized and accepted evil. It is accepted among poultry buyers and sellers as inevitable and is taken into consideration in arriving at the C.I.F.[13] prices quoted by sellers to prospective overseas volume buyers.

[13] Cargo, insurance, freight.



PN–3920

FIGURE 10.—Container being transferred from marshaling yard to dockside in Los Angeles, Calif., by straddle carrier.

PN–3921

FIGURE 11.—Container being loaded aboard containership by shoreside gantry crane.

Furthermore, the insurance coverage provided for the overseas poultry shipments discounted the C.I.F. prices. For this reason, no pilferage costs are given in this report.

Rough handling (fig. 4) was another principal source of loss and damage in the break-bulk shipments. Twelve of the fourteen handlings from origin to destination caused serious box damage, especially where the poultry box was inadequate or poorly made or where the boxes were not well strapped.

The lack of adequate stacking patterns (figs. 2 and 6) in the break-bulk shipments was a major cause of box and product damage. The researchers noted that no prescribed loading patterns were used in the refrigerated holds or lockers of the ships. A great deal of box damage was caused in several test shipments by the en route discharging of cargo at intermediate ports from refrigerated holds. This practice left the remainder of the cargo in disarray when the ship arrived at the next port of call.

The arrival condition of the boxes in the van container shipments (figs. 8 and 9) ranged from good to excellent. There was no shifting of boxes in transit and the stacking patterns remained intact.

ANALYSIS OF TRANSIT, TRANSPORT, AND SHIPPING COSTS

There are many direct and indirect costs in moving poultry from processing plants in the United States to various overseas markets. These costs may be grouped according to the particular services they cover. They include all expenses for moving products from the processing plants to the receiver's premises at the overseas markets.

Transit Costs

Transit costs are the costs to the owner of the products of physically moving them from origin to destination. However, they are not the total costs of getting the product to markets in foreign countries since they include only the freight charges for different forms of transportation that the owner of the shipment must pay to have it moved from origin to destination. The product is packaged in the same way for shipment to domestic markets and packaging is therefore not an additional cost incurred in shipping the poultry to an overseas market. The average transit costs for all the test shipments showed little difference between the van container and the break-bulk system, 5.7 and 5.2 cents per pound, respectively (table 7).

TABLE 7.—*Transit costs for test shipments of U.S. frozen poultry*

Test shipment	Weight	Origin	Destination	U.S. inland freight charges		
				Amount	Percent of total transit costs	Per pound
Paired tests	*Pounds*			*Dollars*	*Percent*	*Cents*
1. Van container	26,969	North Carolina	Italy	[1] 500	24.8	1.9
2. Break-bulk	25,576	do	do	[4] 300	22.3	1.2
3. Van container	32,800	Virginia	Germany	[7] 35	3.5	.1
4. Break-bulk	31,487	do	do	[7] 35	3.6	.1
5. Van container	30,119	Iowa	Italy	[11] 768	32.9	2.5
6. Break-bulk	25,763	do	do	[12] 415.61	27.9	1.6
7. Van container	28,196	Minnesota	Germany	[13] 522.19	37.7	1.8
8. Break-bulk	33,872	do	do	[15] 558.89	33	1.6
9. Van container	34,560	Virginia	Austria	[16] 362.28	21.7	1
10. Break-bulk	36,321	do	do	[15] 272.41	14	.8
11. Van container	36,000	Georgia	Japan	[15] 650	26	1.8
12. Break-bulk	28,020	do	do	[15] 240.75	15	.8
Average:						
Break-bulk						1
Van container						1.52
Miscellaneous tests						
13. Van container	34,525	Nebraska	Germany	[16] 607.25	32.9	1.7
14. Break-bulk	31,575	Virginia	Switzerland	[15] 245.56	13.6	.7
15. Van container	32,770	Nebraska	Germany	[15] 603.02	35	1.8
16. Break-bulk	32,000	Georgia	Greece	[21] 225	15	.7
17. Do	33,000	Virginia	Hong Kong	[15] 214.50	10	.6
Average all tests:						
Break-bulk					17	.9
Van container					26	1.6

[1] Empty container trucked from New Jersey to North Carolina and loaded container returned to New Jersey.
[2] North Atlantic Continental Freight Conference rate from New York to Rotterdam.
[3] Represents truck charge from Rotterdam to Milan.
[4] Truck charge from North Carolina to New York.
[5] Nonconference rate from New York to Genoa.
[6] Trucked from Genoa to Milan.
[7] Truck charge from Broadway, Va., to Baltimore, Md.; charges are low because trucks were used for backhaul of freight.
[8] Conference rate from Baltimore to Bremen.
[9] No charge because delivery was within port area.
[10] Nonconference rate from Norfolk to Hamburg.
[11] Loaded trailer piggybacked to New York, where load was transferred to van container.
[12] Shipment hauled by truck from Iowa to New York.

to overseas markets by methods of transport, 1966–69

Ocean freight charges			Overseas inland freight charges			Total transit costs	Cost per pound
Amount	Percent of total transit costs	Per pound	Amount	Percent of total transit costs	Per pound		
Dollars	*Percent*	*Cents*	*Dollars*	*Percent*	*Cents*	*Dollars*	*Cents*
[2] 899.64	44.8	3.1	[3] 610	30.4	2.2	2,009.64	7.4
[5] 970.52	72.4	3.7	[6] 69.80	5.3	.3	1,340.32	5.2
[8] 984.91	96.5	3	([9])	--	--	1,019.91	3.1
[10] 871.46	91.3	2.8	47	5.1	.1	953.46	3
[2] 954.23	40.9	4.5	[3] 610	26.2	.7	2,332.23	7.7
[5] 977.61	65.6	3.7	[6] 96.66	6.5	.4	1,489.88	5.7
[11] 862.47	62.3	3.1	([9])	--	--	1,384.66	4.9
[14] 1,130.22	67	3.4	([9])	--	--	1,689.11	4.9
[11] 857.52	51	3.5	[17] 450	26.9	1.3	1,670.40	4.8
[15] 1,211.70	62.6	3.3	[19] 450	23	1.2	1,934.11	5.3
[20] 1,791	72.7	5	[17] 19.44	1.3	.1	2,460.44	6.8
[20] 1,295.62	82	4.7	[19] 42.98	3	.2	1,579.35	5.6
------	---	3.6	----	--	.4	------	4.9
------	---	3.7	----	--	1.1	------	5.8
[14] 1,114.19	60	3.6	[19] 122	7.1	.4	1,843.44	5.6
[18] 1,072.66	59.5	3.5	[19] 550	30.5	1.7	1,868.22	5.9
[14] 1,001.73	58.5	3.1	[19] 107	6	.3	1,711.75	5.2
[22] 1,283.25	83	4	32	2	.1	1,540.25	4.8
[23] 1,846.76	88	5.6	[19] 25	2	.1	2,086.26	6.3
------	74.6	3.8	----	9.7	.5	------	5.2
------	60.8	3.6	----	16.3	.8	------	5.7

[13] Shipment loaded in railcar at plant and diverted from break-bulk ship to van container because of labor situation at port.

[14] North Atlantic Continental Freight Conference Tariff No. 27.

[15] Trucker's charge from origin to marine terminal.

[16] Rail charge includes bringing empty van container to shipper's plant and returning loaded container to marine terminal.

[17] Trucker's charge from overseas port to final destination and returning empty container to marine terminal.

[18] Finn Lines—U.S. North Atlantic Continental Eastbound Freight Tariff FMC–1.

[19] Trucker's charge from overseas port to final destination.

[20] Pacific Westbound Conference Local Freight Tariff No. 2, FMC–5.

[21] Contract truck rate to Charleston, S.C.

[22] Charges allocated on basis of chartered rates.

[23] Far East Conference Tariff No. 24, FMC–2.

Transport Costs

Transport costs to the owner of the products consists of the charges he must pay for physical movement of the goods (transit costs) and for protection and facilitation of the movement to get the shipment from origin to destination. Such costs include freight charges for all forms of transportation used in moving the shipment (transit costs) plus forwarding and expediting fees and the insurance.

Transport costs for each of the test shipments studied are given in table 8. The average of all transport costs for the van containers and break-bulk shipments was 5.9 and 5.4 cents per pound, respectively. The van containers would have had a decidedly more favorable cost advantage if each of the inland transport segments of the shipments had been less difficult and costly.[14]

Transport costs in table 8 show that an average of 26 percent of the total transport costs for the van container shipments was incurred in moving the product from the shipper's plant to the port of shipment as compared with an average of 17 percent for the break-bulk shipments. Overseas inland costs averaged for the van container and break-bulk shipments were 16 and 9 percent, respectively, of the total transport costs. Ocean freight charges for the van container and break-bulk shipments averaged, respectively, 58 and 72 percent, of the total transport costs.

U.S. Inland Freight Charges

Inland freight charges for the van containers were usually high because the shipper had to pay for picking up the empty containers and returning the loaded van container to the carrier at the ports. All the empty van containers were obtained from the New York area and most of them were returned to the same area for loading aboard ship. Ports in the Southeast during 1966–69 were just beginning to equip their container ports and prepare for containerships.

The inland charges for the break-bulk shipments were not as great as those for the van container because of the proximity of available ports when the processing plants were located in the Southeastern United States. Shipments from the interior were brought to the east coast ports by truck or rail, whichever was economically advantageous.

Although some rate discounts were offered for shipper loading of the van containers and the receiver unloading the container at the warehouse, considerable difficulty was encountered in moving the containers to and from the ports at reasonable rates. Shipment 9 was the only movement to the port where the rail carrier had established a special commodity rate providing a single reduced rate for taking the empty van container to the shipper's plant and moving the loaded container to port. The inland movements of the remaining van container shipments were all subject to additional charges for taking the empty van container to the shipper's plant. Test shipment 16, for example, was hauled by truck from Georgia to the west coast because refrigerated van container service from the east coast of the United States to the Orient was not available at that time.

Overseas Inland Freight Charges

Land transport of the van containers from the overseas port to inland destinations was also rather costly. At the time of this study, freight rates for inland movement of container shipments from the port of debarkation were in a state of flux. They were apparently higher than might be justified on the basis of costs and volume of traffic.[15]

The railroads in some European countries were not ready to accept van containers because of the lack of suitable equipment and facilities. Some truckers refrained from hauling the containers because of the technical difficulties and insufficient backhaul traffic to make container delivery profitable.

[14] Cost of dispatching empty container from New Jersey to North Carolina for loading is reason for $500 inland transport charge for test shipment 1. The inland charge was only $300 for a subsequent shipment that involved no "deadheading," returning the empty van container.

[15] Current conditions are much improved with acceptance of container traffic by European railroads and use of container trains. Transit times and transport charges for container traffic have been significantly reduced.

Ocean Freight Charges

Ocean freight charges were lower relative to the weight of the cargo on the foreign flag than on the American flag carrier ships. Shipments 1, 3, 9, 13, and 15 were loaded in van containers at the shipper's plant and were not unloaded until they reached the receiver's warehouse. A 10-percent discount was in effect when these shipments were made. Shipments 5, 7, and 11 that were loaded into the van containers at the ports but unloaded at the receiver's warehouse were accorded a 5-percent discount from the published conference rate.

The variations found in ocean freight charges were due to such factors as the commodity shipped, whether the shipment was by van container or break-bulk, whether van container service was used from the shipper's plant to the receiver's warehouse, and whether the ocean carriers were members of a rate conference.

As in the total transit costs, ocean freight charges were the largest single cost element, ranging from 40 to 91 percent of the total transport costs. Inland freight charges for movement of the products to and from the ports, which varied directly with the distance the shipments were transported, were the next largest cost element. Forwarders' fees and insurance were relatively unimportant, averaging 3 percent of the total transport costs for both the break-bulk and van container shipments.

Some of the differences in ocean freight charges were due to the variety of commodities shipped (table 9). Shipments 1–4 consisted of whole turkeys and the rate was $74.75 a long ton, which applied from all the ports from Portland, Maine, to Hampton Roads, Va., to such North Atlantic continental European ports as Antwerp, Bremen, Rotterdam, and Hamburg.[16] Shipments 13 and 14 of turkey thighs and whole turkeys had the same rate of $74.75 per long ton. Chicken legs in shipment 9 were rated $58.50 per long ton (2,240 lb). They were classified by the specific tariff as "poultry, n.o.i." (not otherwise identified) and rated lower. Turkey thighs in shipments 13 and 15 were classified in the same category as whole turkeys and the same rate was charged as for whole turkeys.

Another reason for the variation in ocean freight rates was due to rate changes during this period. For instance, shipment 11 to Tokyo in 1968 was rated $99.50 a long ton and shipments 13 and 17 in 1969 on items with a similar freight classification were rated $101.75 per long ton.

[16] North Atlantic Continental Freight Tariff No. 27, Federal Maritime Commission-2, June 1, 1966.

Shipping Costs

Shipping costs (transport costs plus import duties) are the costs of placing the product at a particular point overseas. When the shipping costs are added to the f.o.b price of the poultry, the result is the cost of the product at the point of delivery in the importing country's physical distribution system. This is the final cost of the product that determines whether the U.S. product will be competitive pricewise with products of the same quality and condition from other sources at given delivery points in the importing country's marketing system.

Shipping costs in table 9 do not include the costs of loading and unloading the shipments because the shipper would incur the same loading costs if he were shipping the poultry to a domestic market as he does in shipping to a foreign market. Similarly the consignees in overseas markets incur about the same costs in unloading the shipments at their premises whether the shipments originate in the United States or in some other country.

Import Duties

The import duties applicable to each of the test shipments are shown in table 9. They were either "specific," a duty based on a standard other than value, or "ad valorem," a duty assessed in proportion to the value of the imported item, or both, and they constituted one of the most important charges encumbering U.S. poultry exports.

Import charges on poultry as levied by the European Economic Community severely restricted the export of U.S. poultry products. Import duties and other entry charges are levied by 108 foreign countries the world over, denying the U.S. shipper the right to export his product on a competitive price basis.

The six test shipments destined for Germany were subject to a customs tax or import duty of 99 marks and 66 pfennigs per kilogram, or $23.73 per 220 pounds of cargo. In addition to the customs duty, these shipments were also subject to a sales or turnover tax of 4 percent of the invoice value.

The customs duty on the Austrian test shipments amounted to 150 shillings per 100 kg, or $5.80 for 220 pounds of poultry. In addition to this import levy, a 9.1-percent import equalization tax on the invoice value was levied. The proceeds from this levy were used by Austria to subsidize its poultry exports.

The poultry bound for Switzerland was subject to a customs duty of 30 francs for 100 kg, or $6.99 for 220 pounds of cargo. Two additional import duties were levied—3 percent of the customs duty for statistical services and a sales tax of 5.4 percent of the total services value.

The test shipment of poultry for Japan was subject to a 20-percent import duty on the invoice value of the cargo.

TABLE 8.—*Transport costs for test shipments of U.S. frozen*

Test shipment	Weight	Origin	Destination	U.S. inland freight charges [1]	
				Amount	Percent of total transport costs
Paired tests	*Pounds*			*Dollars*	*Percent*
1. Van container	26,969	North Carolina	Italy	[4] 500	24
2. Break-bulk	25,576	do	do	[7] 300	22
3. Van container	32,800	Virginia	Germany	[10] 35	3
4. Break-bulk	31,487	do	do	[13] 35	3
5. Van container	30,119	Iowa	Italy	[15] 768	32
6. Break-bulk	25,763	do	do	[7] 415.61	27
7. Van container	28,196	Minnesota	Germany	[16] 522.19	36
8. Break-bulk	33,872	do	do	[17] 558.89	32
9. Van container	34,560	Virginia	Austria	[18] 362.28	21
10. Break-bulk	36,321	do	do	[17] 272.41	14
11. Van container	36,000	Georgia	Japan	[17] 650	25
12. Break-bulk	28,020	do	do	[17] 240.75	14
Miscellaneous tests					
13. Van container	34,525	Nebraska	Germany	[17] 607.25	32
14. Break-bulk	31,575	Virginia	Switzerland	[17] 245.56	13
15. Van container	32,770	Nebraska	Germany	[17] 603.02	34
16. Break-bulk	32,000	Georgia	Greece	[21] 225	14
17. Do	33,000	Virginia	Hong Kong	[23] 214.50	10
Average all tests:					
Break-bulk					17
Van container					26

[1] Van container charges include cost of bringing empty van container from carrier terminal to processing plant.
[2] Includes cost of labor for loading and unloading ships either break-bulk or van container.
[3] Delivery within port area except where noted.
[4] Motor carrier picked up empty van container and delivered loaded container to Port of New York.
[5] North Atlantic Continental Freight Conference rate.
[6] Containers hauled overland by truck from Rotterdam to Milan.
[7] Truck charge from origin to New York.
[8] Nonconference rate charged.
[9] Charges from Genoa to Milan.
[10] Shipper's tractor picked up and delivered van container to Port of Baltimore.
[11] Conference rate—New York to Bremen.
[12] No charge because delivery was within port area.
[13] Shipper's tractor-trailer delivered shipment to Port of Norfolk.

Comparison of the total shipping and total transport costs per pound shows the extent to which the import duties changed the differences between the costs for the two transport methods and for the individual shipments. These data show, for example, that for all the shipments studied, transport costs averaged a little over a third of the total cost of shipping poultry to foreign markets, whereas import duties on the average accounted for more than 60 percent of the shipping cost for the product. Since the basis on which many such assessments, including import duties, is applied is a given percentage of the invoice value of the goods (f.o.b. value plus transport and handling charges), any reduction in handling and transport charges per unit also reduces the per unit cost of the special assessments. This relationship further emphasizes the value of innovations in handling and transport technology in helping to reduce the cost of placing U.S. agricultural products in foreign markets at lower overall costs.

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Forwarders' fees and insurance		Ocean freight charges [2]		Overseas inland freight charges [3]			
Amount	Percent of total transport costs	Amount	Percent of total transport costs	Amount	Percent of total transport costs	Total transport costs	Cost per pound
Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Cents*
36.50	2	[5] 899.64	44	[6] 610	30	2,046.14	7.6
31	2	[8] 970.52	71	[9] 69.80	5	1,371.32	5.4
62.50	6	[11] 984.91	91	([12])	--	1,082.41	3.3
41.50	4	[14] 871.46	88	47	5	994.96	3.1
36.50	1.5	[5] 954.23	40	[6] 610	26	2,368.73	7.9
31.50	2	[8] 977.61	64	[9] 96.66	7	1,521.38	5.9
56	4	[5] 862.47	60	([12])	--	1,440.66	5.1
48	3	[8] 1,130.22	65	([12])	--	1,737.11	5.1
62	4	[5] 857.52	49	[19] 450	26	1,732.40	5
48	2	[5] 1,211.70	61	[19] 450	23	1,982.11	5.4
175.66	7	[20] 1,791	67	[19] 19.44	1	2,636.10	7.3
130.05	7	[8] 1,295.62	76	[19] 42.98	3	1,709.40	6.1
56	3	[5] 1,114.19	59	[19] 122	6	1,899.44	5.5
48	2	[5] 1,072.66	56	[19] 550	29	1,916.22	6.1
56	3	[5] 1,001.73	57	[19] 107	6	1,767.75	5.4
50.94	3	[22] 1,283.25	81	32	2	1,591.19	5
82.50	4	[8] 1,846.76	85	[19] 25	1	2,168.76	6.6
-----	3	------	72	-----	9	-------	5.4
-----	3	------	58	-----	16	-------	5.9

[14] Nonconference rate—Norfolk to Hamburg.

[15] Product shipped by piggyback trailer to New York and transferred to van container.

[16] Shipment loaded into refrigerated railcar at plant and diverted from break-bulk ship to van container because of labor situation at port.

[17] Trucker's charge from origin to marine terminal.

[18] Rail charge includes bringing empty van container to shipper's plant and returning loaded container to marine terminal.

[19] Trucker's charge from overseas port to final destination and returning empty container to marine terminal.

[20] Pacific Westbound Conference Local Freight Tariff No. 2, FMC-5.

[21] Truck rate from Atlanta to Charleston, S.C.

[22] Allocated on basis of chartered rates.

[23] Contract truck rate to Norfolk.

TABLE. 9.—*Shipping costs for test shipments of U.S. frozen poultry to overseas markets by method of transport, 1966–69*

Test shipment	Commodity	Weight	Origin	Destination	Transport costs [1]			Import duties			Total shipping costs	Cost per pound
					Total	Per pound	Percent of total shipping costs	Total	Per pound	Percent of total shipping costs		
Paired tests		*Pounds*			*Dollars*	*Cents*	*Percent*	*Dollars*	*Cents*	*Percent*	*Dollars*	*Cents*
1. Van container	Turkeys	26,969	North Carolina	Italy	2,046.14	7.6	39	3,265.95	12	61	5,312.09	19.6
2. Break-bulk	do	25,576	do	do	1,371.32	5.4	31	3,097.62	12.1	69	4,468.94	17.5
3. Van container	do	32,800	Virginia	Germany	1,082.41	3.3	22	3,972.08	12.1	78	5,054.49	15.4
4. Break-bulk	do	31,487	do	do	994.96	3.1	21	3,811.99	12	79	4,806.95	15.1
5. Van container	Turkey parts	30,119	Iowa	Italy	2,368.73	7.9	40	3,647.41	12	60	6,016.14	19.9
6. Break-bulk	do	25,763	do	do	1,521.38	5.9	33	3,119.90	12.1	67	4,641.28	18
7. Van container	Turkeys	28,196	Minnesota	Germany	1,440.66	5.1	30	[2] 3,414.54	12	70	4,855.20	17.1
8. Break-bulk	do	33,872	do	do	1,737.11	5.1	30	[2] 4,101.90	12.1	70	5,839.01	17.2
9. Van container	Chicken legs	34,560	Virginia	Austria	1,732.40	5	46	[3] 2,027.03	6	54	3,759.43	11
10. Break-bulk	Turkeys	36,321	do	do	1,982.11	5.4	48	[3] 2,129.88	5.8	52	4,111.99	11.2
11. Van container	Chicken legs	36,000	Georgia	Japan	2,636.10	7.3	48	[4] 2,880.00	8	52	5,516.10	15.3
12. Break-bulk	do	28,020	do	do	1,709.40	6.1	40	[4] 2,520.00	8.8	60	4,229.40	14.9
Miscellaneous tests												
13. Van container	Turkey thighs	34,525	Nebraska	Germany	1,899.44	5.5	31	[2] 4,180.98	12.1	69	6,080.42	17.6
14. Break-bulk	Turkeys	31,575	Virginia	Switzerland	1,916.22	6.1	54	[3] 1,615.98	5.2	46	3,532.20	11.3
15. Van container	Turkey thighs	32,770	Nebraska	Germany	1,767.75	5.4	32	[2] 3,698.45	11.3	68	5,466.20	16.7
16. Break-bulk	Broilers	32,000	Georgia	Greece	1,591.19	5	21	5,946.60	18.5	79	7,537.79	23.5
17. Do	Chicken wings	33,000	Virginia	Hong Kong	2,168.76	6.6	100	([5])	---	--	2,168.76	6.6
Average all tests:												
Break-bulk						5.4	42		10.8	58		15
Van container						5.9	36		10.7	64		16.5
Average						5.6	39		10.8	61		15.8

[1] Information carried over from table 8.
[2] Includes 4-percent sales tax and import duty.
[3] Customs duty and sales tax based on invoice value.
[4] Duty based on percentage of invoice value.
[5] Hong Kong, a duty-free area, levied no import duty.

The average transport costs per pound for all test shipments was 5.9 cents for the van container and 5.4 cents for the break-bulk shipments (table 8). The total shipping costs per pound averaged 16.5 cents for the van containers and 15 cents for the break-bulk shipments (table 9). The transport costs for the container shipments were higher principally because of the unusually high charges for land movement of some shipments to and from origin and destination ports.

Although the van container method of transporting poultry did not provide any advantage costwise over the conventional or break-bulk shipments, it did offer some advantages to the shippers and receivers. In all the van container test shipments, the product arrived in much better condition. There was no pilferage and very little product or box damage due to rough handling. During transit the poultry products were much better protected from origin to destination and were not subject to any sharp temperature variations. The van container system gave better overall physical performance than the break-bulk method of shipping.

ECONOMIC COSTS

The total economic costs of the two methods of handling and transporting shipments of frozen poultry were determined. Economic costs include the expense of the total physical and human resources used to produce the required transport services in moving the product from origin to destination. These costs are expressed in terms of capital and labor inputs and are derived from time studies of various operations and accounting costs from different sources.

Use of the accounting costs and other data required to develop the economic costs also provided an opportunity to identify and determine the relative importance of the various cost elements in each segment of the intermodal handling and transport system through which the product moved. Such comparisons help to spotlight areas of major costs where the payoff in terms of cost reductions through innovations in technology would likely be the greatest and where further research is needed.

Most of the economic costs for the ocean transport segment of the through shipments were synthesized from data in the carriers' reports filed with the U.S. Maritime Administration for similar transport operations. The economic costs were developed by the method and procedures formulated by the researchers.

Materials-Handling Costs

The physical resources or capital inputs used for transferring the shipment from the shipping dock onto the transport vehicle were developed in table 16 (appendix) from manufacturers' initial ownership and maintenance costs and were converted to an hourly basis. The average use was assumed to be 2,000 hours per year. Capital inputs or physical resources used by the shipper beyond the loading dock into the cold storage warehouse are not considered here because they are facilities common to the domestic as well as the overseas trade.

Table 10 includes the economic costs of both capital and labor inputs for materials handling from origin to destination of the test shipment. The hourly ownership and operation costs in table 16 are converted by the actual equipment time and apportioned on a capital and labor basis in table 10.

Inland Carrier's Costs

The economic costs for the U.S. inland motor carriers were identified and developed on a constructed basis. Eight of the fourteen test shipments were moved from the shipper's plant to the port by trucks owned by uncertificated carriers, who were not required to file financial statements with the Interstate Commerce Commission.[17] Actual cost input data were not

[17] Sect. 203(b)(4a)(4b) of the Motor Carrier Act of 1935 provides that motor vehicles owned, controlled, and operated by any farmer or farmers' cooperative association and used solely in the transportation of agricultural commodities and products thereof, or in the transportation of supplies to farms, are exempt from application of the Act as it relates to regulation of rates and area of operations by the Interstate Commerce Commission.

available from the U.S. inland carriers, and a representative or average cost figure was developed from a sample of 31 refrigerated motor carriers selected at random from a list of motor carriers maintained by the U.S. Interstate Commerce Commission. Revenues, expenses, and statistics as filed by the carriers with the Interstate Commerce Commission on Form QFR-1 were used for computing a cost per vehicle mile for each of the carriers listed for 1967 and 1968 as shown in table 17 (appendix). An arithmetic average was computed for the individual carrier's mileage cost and this average cost per vehicle mile was used in summarizing total cost input data.

Data in table 17 on the total cost per vehicle mile for 1968 show that the arithmetic average was 0.590 dollar per vehicle mile. The economic cost for the U.S. inland transport from the shipper's plant to the port as shown in table 10 is developed as follows: The U.S. inland miles are multiplied by the average capital cost per vehicle and divided by the weight of the shipment.

The economic cost data for the three rail test shipments were developed by using the cost scales and unit costs as constructed by the Interstate Commerce Commission on a territorial basis. The data in table 10 for the U.S. inland transport from origin to port of embarkation of the three rail test shipments—5, 7, and 9—were computed from fully distributed costs published by the I.C.C.[18]

Numerous difficulties in calculating vehicle operating and overhead costs for the overseas inland transport were encountered. Most of the overseas inland carriers that transported the test shipments from the ports to the final destination were unable to provide the researchers with any meaningful data on operation, maintenance, and capital costs or overhead. A few of the carriers had some of the required information, but they were reluctant to release it.

[18] INTERSTATE COMMERCE COMMISSION. RAIL CARLOAD COSTS BY SCALES BY TERRITORIES FOR ONE YEAR 1967. 150 pp. Washington, D.C. 1969.

TABLE 10.—*Economic costs for individual handling and transport segments of*

Test shipment	Mode of U.S. inland transport	U.S. inland transport to port	Overseas inland transport	Weight of shipment	Economic cost per pound of loading shipment		
					Capital	Labor	Total
		Miles	*Miles*	*Pounds*	*Cents*	*Cents*	*Cents*
1. Van container	Truck	559	720	26,969	0.006	0.010	0.016
2. Break-bulk	do	559	25	25,576	.014	.012	.026
3. Van container	do	155	65	32,800	.003	.011	.014
4. Break-bulk	do	155	05	31,487	.011	.011	.022
5. Van container	Rail	1,090	720	30,119	.003	.006	.009
6. Break-bulk	Truck	1,008	25	25,763	.010	.006	.016
7. Van container	Rail	1,447	05	28,196	.004	.014	.018
8. Break-bulk	Truck	1,336	05	33,872	.005	.007	.012
9. Van container	Rail	342	725	34,560	.004	.008	.012
10. Break-bulk	Truck	342	725	36,321	.006	.006	.012
11. Van container	do	2,215	12	36,000	.010	.009	.019
12. Break-bulk	do	301	12	28,020	.006	.006	.012
13. Van container	do	1,318	60	34,525	.003	.007	.010
14. Break-bulk	do	238	530	31,575	.008	.007	.015
15. Van container	do	1,318	60	32,770	.003	.012	.015
16. Break-bulk	do	301	07	32,000	.008	.007	.015
17. Do	do	238	03	33,000	.006	.007	.013
Total					.110	.146	.256
Average					.006	.009	.015
Percent of total cost					40	60	

[1] Developed from time studies of labor and equipment usage and accounting costs and carried forward to table 14.

Since data on overseas inland trucking costs are very meager, constructing costs on the basis of secondary data was not feasible. The only recourse available was the use of certain detailed vehicle operating costs developed in a study by the World Bank.[19] The study is primarily concerned with quantifying the economic costs and benefits of better roads in order to apply economic criteria to the allocation of available service resources.

Using the detailed vehicle operating costs by type of vehicle, road, and speed, a representative figure was developed that was divided into capital and labor inputs and used as the average or typical operating cost figure on a per mile basis. Table 10 provides a breakdown of vehicle operating costs on a capital and labor basis for overseas inland transport of each test shipment. These costs were broken down into the following categories: (1) Fuel consumption, (2) engine oil consumption, (3) time wear, (4) depreciation and interest, (5) maintenance, and (6) driver's time.

Ocean Carrier's Costs [20] [21]

The total maritime costs of the shipper to the consignee system are developed here on a voyage basis because steamship companies customarily accumulate costs on a voyage-by-voyage basis. These costs are combined with the direct transport costs developed previously to arrive at the total costs.

The items included in the total pier-to-pier costs were grouped in four categories pre-

[19] DeWeille, Jan. QUANTIFICATION OF ROAD USER SAVINGS. 93 pp. International Bank for Reconstruction and Development, Washington, D.C. 1966.

[20] For a detailed description of the operating expense categories, see the appendix.

[21] Uniform System of Accounts for Operating Differential Subsidy Contractors, Federal Maritime Board, Maritime Administration, U.S. Department of Commerce, Revised General Order 22, Title 46, Ch. II, Pt. 282.

through intermodal shipments of frozen poultry by method of transport, 1966–69 [1]

Economic cost per pound of U.S. inland transport			Economic cost per pound of overseas inland transport			Economic cost per pound of ocean transport		
Capital	Labor	Total	Capital	Labor	Total	Capital	Labor	Total
Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
0.877	0.275	1.152	0.305	0.239	0.544	2.513	1.171	3.684
.925	.290	1.215	.011	.039	.050	1.791	2.065	3.856
.200	.063	.263	.019	.044	.063	2.023	.965	2.988
.208	.065	.273	.002	.045	.049	1.235	1.937	3.172
1.460	.487	1.947	.273	.353	.626	3.309	1.616	4.925
1.656	.519	2.175	.011	.039	.050	1.417	1.848	3.265
1.288	.429	1.717	.002	.051	.053	2.025	1.040	3.065
1.669	.523	2.192	.002	.042	.044	.843	1.206	2.049
.830	.277	1.107	.240	.413	.653	1.440	.671	2.111
.398	.125	.523	.228	.198	.426	.984	1.183	2.167
2.604	.816	3.420	.004	.069	.073	1.929	.834	2.763
.455	.142	.597	.005	.089	.094	1.722	2.544	4.266
1.616	.506	2.122	.015	.041	.056	1.440	.560	2.000
.319	.100	.419	.192	.250	.442	1.325	1.631	2.956
1.702	.533	2.235	.016	.044	.060	3.635	1.923	5.558
.398	.125	.523	.002	.031	.033	.993	1.361	2.354
.305	.096	.401	[2] .001	[2] ---	[2] .001	1.110	1.100	2.210
16.910	5.371	22.281	1.327	1.987	3.317	29.734	23.655	53.389
.995	.316	1.311	.078	.124	.195	1.749	1.391	3.140
76	24	----	40	60	----	56	44	----

[2] Omitted in calculating average of overseas inland costs.

scribed by the U.S. Maritime Administration for subsidized operators.

Voyage expense:
(1) Operating expense
(2) Capital expense
(3) Inactive vessel expense

Port expense:
(1) Land terminal (origin)
(2) Land terminal (destination)
(3) Reefer expense (land)
(4) Reefer expense (sea)
(5) Chassis expense (land)
(6) Container award (U.S. only)
(7) Platform origin

Cargo handling expense:
(1) Terminal marine (origin)
(2) Terminal marine (destination)

Administrative and general expenses:

The cost elements in this study are those made available from the cost breakdown provided by the ocean carriers and are intended to simplify calculations required in making a large number of cost computations. For this study each of the expense items in the calculations is discussed in the appendix.

Shipboard handling costs vary considerably between carriers and types of ships. This is especially true for refrigerated cargo. Although the figures for the break-bulk movement do not cover precisely the same commodities as shipped in the van container, certain adjustments were made in the existing break-bulk cost data to reduce some of the variances in the data. The break-bulk cost data include costs that should be assigned wholly to refrigerated cargo. These data were obtained from ocean carriers hauling agricultural perishables, from the U.S. Maritime Administration's computerized data bank, and from interviews with naval architects and marine engineers. Capital investment, maintenance, and repairs wholly attributable to the ship's refrigeration system were included to minimize the possibility of underestimating the costs of shipboard refrigeration systems by mixing them with the general cargo costs.

TABLE 11.—*Containership operating costs per voyage by type*

Voyage costs [1]	C-2 vessels							
	Voyage B		Voyage C		Voyage D		Voyage E	
	Amount	Percent of total voyage expenses	Amount	Percent of total voyage expenses	Amount	Percent of total voyage expenses	Amount	Percent of total voyage expenses
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Wages:								
Straight time	20,960	24	22,406	22	21,960	22	25,588	22
Overtime	12,328	14	13,151	13	15,342	16	17,869	16
Miscellaneous payroll	1,336	2	1,218	1	168	.2	210	.2
Payroll taxes	2,310	2	2,236	2	1,804	2	1,686	2
Fringe benefits	9,966	11	11,414	11	11,534	12	14,690	13
Bunker fuel	11,706	13	12,239	12	12,139	12	14,307	13
Diesel fuel	502	.7	512	.5	520	.5	613	.5
Subsistence	2,047	2	2,710	3	2,122	2	2,501	2
Stores and supplies	4,024	5	4,499	5	4,173	4	4,918	4
Miscellaneous expenses	1,883	2	2,132	2	1,776	2	1,634	1
Repairs and maintenance	16,069	18	19,799	20	16,682	17	19,661	17
Insurance:								
Hull and machinery	2,331	3	2,786	3	2,452	3	2,888	3
War risk	274	.5	448	.5	379	.3	447	.3
Shipper	1,052	1	3,304	3	4,791	5	4,798	4
Illness [2]	785	.8	960	1	1,079	1	1,271	1
Deductible [2]	1,215	1	1,395	1	1,260	1	1,485	1
Total	88,788	100	101,209	100	98,181	100	114,566	100

[1] For definitions, see appendix.
[2] Public liability indemnity.

The cost figures used in the analysis of the container operations were obtained directly from the carriers. The data used in the break-bulk operation are representative values because they are based on operating expense data extrapolated from financial statements filed by a number of subsidized operators.

Table 11 provides the operating or active vessel expenses for the ships that carried the van container test shipments. All figures are actual costs provided by the carriers from their accounting records. The data, when necessary, were adjusted to preserve their proprietary nature. Some of the differences in the total expenses are due to variations in the length of the voyage and the type of ship used.

The most significant cost items in table 11 are the wages and the subsistence for the ship's crew, which accounted for over half of all voyage expenses. The other important cost items are insurance, repairs, and maintenance of the ship. Although employees' wages were a significant part of vessel operating expenses for a containership, they are not, in comparison to a break-bulk operation, as large a proportion of the total voyage cost.

Another important capital input for the containership operator is the investment in the refrigeration equipment and the van container chassis. Tables 18 and 19 (appendix) include data on the cost of these items.

Depreciation and maintenance costs for the refrigerated van containers are shown in table 18. These containers are expensive, costing about three times as much as a dry-cargo van container. Thus the capital requirement and inputs of the van container carrier were significantly increased because of the necessary investment in refrigerated van containers. This investment, for example, was $189.40 per van container for voyage A and $79.60 for voyage B. The assignable costs per shipment rose in direct proportion to the number of days the containers were in use, either on land or at sea.

of vessel and type of expenditures, 1969–69

C-3 vessels						T–2 vessels	
Voyage G		Voyage A		Voyage F		Voyage H	
Amount	Percent of total voyage expenses	Amount	Percent of total voyage expenses	Amount	Percent of total voyage expenses	Amount	Percent of total voyage expenses
Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
19,800	25	21,924	20	20,104	22	20,963	21
10,066	13	13,658	13	14,518	16	14,792	15
298	.5	1,116	1	214	.1	429	.7
2,087	3	1,359	1	1,423	2	1,780	2
9,345	12	19,059	19	10,982	12	16,346	16
12,216	15	12,750	12	12,343	13	16,875	17
556	.7	600	.5	503	.5	135	.3
2,206	3	3,330	3	3,204	3	2,106	2
3,667	5	4,170	4	4,071	4	3,375	3
2,043	2	2,410	2	1,883	2	3,489	3
12,308	15	17,100	16	11,531	13	14,256	14
2,370	3	3,115	2	3,244	4	3,175	3
264	.3	722	.5	491	.4	1,076	1
361	.5	2,254	2	5,496	6	----	--
757	1	1,350	1	1,237	1	1,092	1
1,170	1	3,505	3	1,305	1	1,215	1
79,514	100	108,422	100	92,549	100	101,104	100

Table 19 presents ownership and operating expenses for the van container chassis. Although the daily costs are relatively small, they give some indication of capital requirements of the refrigerated van containers and part of the operating costs. From three to four van container chassis are necessary to back up each van container body.

The capital inputs of depreciation are shown in table 20 (appendix), the inactive and active vessel expenses in table 21, and the combined voyage and containership expenses in table 22. The difference between $352 per loaded van container for voyage A and $1,132 for voyage G is caused by different rates of equipment utilization, which significantly affect the costs of both the capital and labor inputs to the van container transportation system.

The port or terminal expenses for the loading and unloading operations of the container carriers are shown in table 23 (appendix). These expenses are an important part of the carriers' total operating costs, and next to voyage expenses, they are the next most important expense. Port expenses contribute significantly to the capital and labor inputs required by the marine segment of intermodal transport. The port expenses at origin are higher than those at destination, reflecting principally the higher labor costs at U.S. ports. A U.S. Department of Commerce study also found that 40 to 70 percent of unit shipping costs is incurred in port with costs in U.S. ports from two to three times greater than in foreign ports.[22]

Discussion

Table 23 (appendix) includes the capital and labor inputs of the marine carriers for selected test shipments. These data show some of the basic differences between the containership and the break-bulk or conventional ship. For instance, capital input exceeded labor input for the van container system and labor input exceeded capital input for the break-bulk system. For the containerized and break-bulk shipments the capital input averaged 67 and 42 percent and the labor input averaged 33 and 58 percent, respectively, of the total capital and labor inputs.

Table 10 presents the economic costs for the ocean carrier's van container versus the break-bulk shipments allocated on a cents-per-pound basis. It summarizes the costs developed for all the test shipments apportioned on a capital and labor basis. The capital intensiveness of the containerized transport method is apparent in comparison with that of the break-bulk mode of shipping. Of equal importance in this comparison is the cost of labor in both the break-bulk and the containerized shipping and its greater importance in the former. The higher average for the capital input of 56 percent to 44 percent for the labor input is partly explained by the high capital investments required at the outset of containerized service to Europe during 1966-69.

Table 12 presents the operating costs, including port or terminal costs, for the van container for each voyage on which test shipments were carried. The total economic cost for moving a van container on voyage G was only $669.88, whereas the cost of voyage H amounted to $1,721.53. The wide variation was due to the vessel expense, which contributed 25 to 50 percent of the total voyage cost. The operating costs in table 12 are the total costs of the ocean carrier for transporting the shipments from port to port. The most significant factor in a study of the capital and labor inputs of the containerized carrier is the capital requirements. Because of its capital intensiveness, the containership must have a high rate of utilization to operate economically. The containership is subject to much greater economies of scale.

The utilization of containerships was much better than that of the break-bulk ships. Each of the containerships hauling the van container test shipments was unloaded and reloaded in 12 to 24 hours, and the ships seldom spent more than a day in each port of call. The test shipments on the break-bulk ships were subject to interminable delays in port. For instance, one shipment was delayed 3 days in Genoa before unloading began and then 7 days elapsed before the ship's cargo was discharged and the ship loaded with outbound freight. Another shipment was delayed 4 days because the ship

[22] LITTON SYSTEMS, INC. OCEANBOUND SHIPPING: DEMAND AND TECHNOLOGY FORECAST. 163 pp. Culver City, Calif. 1968.

TABLE 12.—*Operating costs for overseas transport of van containers of U.S. frozen poultry by voyage, 1966–69*

Type of costs	Inputs for indicated voyage								Total	
	A	B	C	D	E	F	G	H	Amount	Proportion of total cost
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Percent*
Vessel expense	352.00	251.00	743.00	464.00	358.00	406.00	236.00	1,132.00	3,942.00	47.6
Terminal marine (origin)	53.05	36.18	97.36	42.07	42.97	41.50	40.76	97.61	451.50	5.5
Terminal marine (destination)	42.22	41.96	254.10	53.58	70.67	33.90	40.32	107.16	643.91	7.8
Reefer expense (land)	112.70	78.40	14.70	29.40	102.90	58.90	4.90	14.70	416.60	5.0
Reefer expense (sea)	76.70	59.00	64.90	88.50	88.50	88.50	76.70	70.80	613.60	7.4
Chassis expense (land)	46.23	32.16	6.03	12.06	42.21	24.12	2.01	6.03	170.85	2.1
Container award (U.S. only)	12.55	14.68	16.01	11.71	14.60	15.60	14.89	16.22	116.26	1.4
Land terminal (origin)	12.12	14.19	17.54	12.93	16.07	17.15	16.36	17.83	124.19	1.5
Land terminal (destination)	15.79	11.55	90.39	66.66	68.55	88.37	69.80	76.07	487.18	5.9
Administrative and general	141.18	165.33	180.70	132.26	164.82	176.18	168.14	183.11	1,311.72	15.8
Total	864.54	704.45	1,484.73	913.17	969.29	950.22	669.88	1,721.53	8,277.81	100.0

could not be berthed owing to overcrowding at the port. The lack of stevedores caused a 2-day delay before unloading another test shipment.

The containerships and break-bulk ships hauling the test shipments on the North Atlantic route averaged 20 and 32 days, respectively, for a round trip. Of this time, the containership spent only 7 days in port and the break-bulk ships required 18 days. This same time-movement profile projected on a yearly basis enables the containership to make 18 round trips per year to only 12 for the break-bulk ship. The reduced port turn-around time for containerships represents a major economy for the ocean carrier. Two containerships on a particular trade route can make as many round trips per year as three break-bulk ships.

Table 13 shows the relationship of origin and destination port expenses to total voyage costs for the van container and break-bulk shipments. For break-bulk shipments, origin port expenses averaged 25.57 percent of the total voyage costs as compared with 5.21 percent for container shipments. Destination port expenses for break-bulk shipments averaged 11.39 percent of total voyage costs as compared with 9.06 percent for containerized shipments. The smaller percent difference of the total voyage expenses in destination port expenses reflects the lower cost of overseas stevedore labor.

Total Economic Costs [23]

Total economic costs in moving poultry from the shipping plant to the receiver's warehouse are shown in table 14. The data show the capital intensiveness of the van container system of handling and transport as compared with that of the break-bulk method. For the van container shipments, an average of 68 percent of the total costs was in the form of capital resources as compared with 51 percent for the break-bulk shipments. Labor costs for the van container shipments averaged 32 percent as compared with 49 percent for the break-bulk shipments.

[23] These include capital and labor inputs or physical and human resources incurred in producing the services.

The data in table 14 and the differences they show between the two methods of handling and shipment are representative only of the shipments in this study. Studies of other shipments of the same products between the same points over different routes or on different voyages or different carriers would give a slightly different distribution of costs than that shown in this table. This would be due to utilizing the capital and labor resources in different proportions because of using different carriers and different rates of capital equipment utilization, which are partly due to different transit times, different equipment, different labor

TABLE 13.—*Distribution of port expenses by origin and destination for test shipments of U.S. frozen poultry by voyage and method of transport, 1966–69*

Voyage	Proportion of total voyage expenses for—					
	Van container shipments at—			Break-bulk shipments at—		
	Origin	Destination	Total	Origin	Destination	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
A	4.95	9.22	14.17	30.23	12.87	43.10
B	4.23	5.52	9.75	27.06	10.53	37.59
C	6.14	4.88	11.07	32.40	10.25	42.65
D	4.43	8.32	12.75	19.35	8.63	27.98
E	4.17	7.20	11.37	18.08	9.60	27.68
F	5.36	11.37	16.73	29.13	15.39	44.52
G	6.49	17.11	23.60	24.58	13.23	37.81
H	5.91	8.85	14.76	23.74	10.60	34.34
Average	5.21	9.06	14.27	25.57	11.39	36.96

TABLE 14.—*Total economic costs of handling and transporting U.S. frozen poultry to overseas markets by method of transport* [1]

Test shipment	Weight	Economic cost per pound of van container test shipments			Economic cost per pound of break-bulk test shipments		
		Capital	Labor	Total	Capital	Labor	Total
	Pounds	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1. Van container	26,969	3.701	1.695	5.396	-----	-----	-----
2. Break-bulk	25,576	-----	-----	-----	2.741	2.406	5.147
3. Van container	32,800	2.245	1.083	3.328	-----	-----	-----
4. Break-bulk	31,487	-----	-----	-----	1.456	2.058	3.514
5. Van container	30,119	3.585	1.975	5.560	-----	-----	-----
6. Break-bulk	25,763	-----	-----	-----	3.094	2.412	5.506
7. Van container	28,196	2.031	1.105	3.136	-----	-----	-----
8. Break-bulk	33,872	-----	-----	-----	2.519	1.778	4.297
9. Van container	34,560	1.684	1.092	2.776	-----	-----	-----
10. Break-bulk	36,321	-----	-----	-----	1.616	1.512	3.128
11. Van container	36,000	4.547	1.728	6.275	-----	-----	-----
12. Break-bulk	28,020	-----	-----	-----	2.188	2.781	4.969
13. Van container	34,525	3.074	1.114	4.188	-----	-----	-----
14. Break-bulk	31,575	-----	-----	-----	1.884	2.010	3.894
15. Van container	32,770	5.356	2.512	7.868	-----	-----	-----
16. Break-bulk	32,000	-----	-----	-----	1.401	1.524	2.925
17. Do	33,000	-----	-----	-----	1.422	1.203	2.625
Total	-----	26.223	12.304	38.527	18.321	17.684	36.005
Average	-----	3.278	1.538	4.816	2.035	1.965	4.000
Percent of total	-----	68	32	---	51	49	---

[1] Calculated from data in table 10.

sources, and various other factors. However, if the shipments used in such a study were reasonably representative of those moving on a regular commercial basis by both methods of shipping, the distribution of capital and labor costs should be in the same direction and should roughly approximate those shown in table 14.

The distribution of capital and labor costs in table 14 suggests one important conclusion. Since the van container system of handling and transport is capital intensive, the major avenue to reducing the costs is through innovations that will step up the rate of equipment utilization to make more effective use of the capital input. Such steps would of necessity include speeding up the handling, transport, and delivery of the refrigerated van containers. The marketing and distribution of all shipments of U.S. agricultural perishable products to world markets would further benefit from such steps through reduced delivery time for the shipments.

COMPARISON OF BREAK-BULK AND VAN CONTAINER TRANSPORT SYSTEMS

Table 15 lists the total costs for the various functional elements in each transport system. First, the potential for reduced costs for packaging in the van container shipments is evident. The cost of packaging amounts to 1.1 cents per pound for the break-bulk shipments and 0.96 cent for the van container shipments. With the van container, the export packaging requirements are less. For instance, strapping is eliminated and a 200-pound test board box might in some instances be substituted for a 275-pound test box used in break-bulk shipments.

Stenciling of individual boxes can also be eliminated in the van container shipments. Fiberboard boxes of 200- and 250-pound test strength corrugated board and strapped with only one steel band or no bands arrived in European markets in as good condition as fiberboard boxes of 275-pound test strength board strapped with two steel bands. Reduced amounts of packaging also reduce the weight and size of the individual units shipped and thereby help to lower freight costs.

Origin loading costs for the van container and the break-bulk shipments were about the same. The preshipment handling and truck-loading methods at the poultry-processing plants were similar for both shipments. There were therefore no significant differences in labor costs for loading the refrigerated van containers and the over-the-road trailers.

The slight difference of 0.01 cent per pound between the van container and the break-bulk shipment for plant loading was caused by the delays required for stamping and marking the boxes for export in the break-bulk shipments. Van container shipments did not require stenciling, stamping, or marking of the boxes.

There was no difference in the cost for unloading at the overseas receiver's plant between the van container and break-bulk shipments.

The U.S. inland transport averaged 0.9 and 1.6 cents per pound for the break-bulk and van container shipments, respectively. The shipments were loaded in the container at the shipper's plant; however, the principal problem was obtaining sufficient van containers for loading. All the carrier's containers were stored in marshaling yards in the New York area and the land carrier had to make two round trips in order to get the loaded container to the port for shipments.

The high cost of U.S. inland transport for the van containers during this study was due to the lack of facilities and capabilities of the ocean carriers to provide van containers to the shipper at a reasonable cost. At the present time with pools of van containers located at more strategic points around the country and the opening of several container ports at various locations on the east and gulf coasts, the delivery of van containers to the shippers has been simplified and is less costly.

The cost for ocean transport for the van container shipments shown in table 15 was 0.2 cent per pound less than the break-bulk shipments. Most of the benefits accruing to

TABLE 15.—*Total costs per pound of handling and transporting U.S. frozen poultry to overseas markets by method of transport, 1966–69* [1]

Mode of shipment	Packaging	Plant loading and unloading	U.S. inland transport	Ocean transport	Overseas inland transport	Destination unloading	Forwarders' fees and insurance [2]	Import duties	Loss and damage	Total cost
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
Break-bulk	1.10	0.04	0.9	3.8	0.5	0.03	0.20	10.8	[3] 0.001	17.371
Van container	.96	.03	1.6	3.6	.8	.04	.18	10.7	[4] 0	17.91

[1] Data extrapolated from paired test shipments as shown in tables 1 and 7–9. Direct costs to shippers and receivers from packaging, handling, transporting, and importing.

[2] Includes costs of documentation at 0.05 cent per pound.

[3] Based on experimental percentage for loss and damage of ¼ of 1 percent of invoice value.

[4] No evidence of loss or damage on any of the van container shipments.

shippers by van container were in better arrival condition of the product, elimination of most pilferage, maintenance of the product from origin to destination in a better environment, and providing door-to-door delivery for the shipments.

Since most of the advantages of containerization are in the operational areas controlled by the ocean carriers, many of the benefits accrue directly to the carrier and only indirectly to the shipper. For instance, reduction in handling and faster turn-around time for containerships and greater utilization of equipment are a few of these benefits that eventually should be reflected to the shipper in the lower transport charges and better arrival condition of the product.

Overseas inland transport for van containers often involved high charges for extra handling because of the lack of container facilities and adequate transportation service in several countries during these tests. Long highway hauls were frequently necessary to get the van container shipments to their destination. In addition, most of the European railroads had not begun to provide facilities for regularly scheduled transport of van containers. Van containers shipped to Italy had to be unloaded in Rotterdam and trucked to their destination in that country.

Since that time, most countries have established container handling facilities at several major port areas, and it is no longer necessary to make extended overland trips by rail or highway to deliver van container shipments to many points throughout Europe. Furthermore, European railroads have established frequent, regularly scheduled container trains to several points in Europe. There is an indication that the 0.8 cent per pound required for inland transport of the van containers in the test shipments will be significantly reduced as transportation facilities and services are improved and the volume of container traffic increases.

Destination unloading cost of 0.03 cent for the break-bulk shipment (table 15) will remain relatively constant. Many European receivers of poultry lack mechanical handling equipment. Most of the unloading at destination observed during the test shipments was manual. Fortunately destination unloading cost does not constitute a significant part of the total cost because there are not likely to be many improvements in this area in the near future.

Forwarders' fees and insurance charges of 0.2 and 0.18 cent per pound for break-bulk and van container shipments, respectively, should improve when better arrival condition of van container shipments with fewer claims is reflected in lower insurance rates. Although none of the van container test shipments were subject to any claims, cargo insurance rates were set on the basis of experience tables established by marine underwriters.

Forwarders' fees both in this country and overseas are fixed, having been set by practice and experience and there is very little likelihood of any appreciable change.

Import duties constitute the most important single cost of the test shipments (table 15). Practically every country levies some form of import duties on poultry products. For instance, the European Economic Community has raised several barriers to the imports of poultry. They take the form of various import duties designed to preempt the market by pricing U.S. products out of the EEC market area. Of the countries to which the experimental shipments were destined, only Hong Kong did not levy some form of an import duty. Not only did the U.S. exports of poultry products contend with the unreasonably high levies but also they were confronted with large-scale export subsidies of competing poultry products. The application of these levies very often doubled the price of the product.

Documentation is also an area where cost reductions in export shipments can be achieved. It is a real obstacle to the shipper and is one of the principal services provided by the freight forwarder. Complex and costly documentation is one of the major problems not only for export poultry shipments but for all international trade. Efforts by both business and government toward simplifying shipping documents and eliminating others should provide some cost relief in this area of international trade.

Loss and damage cost is one of the more important differences in performance between the break-bulk and the van container methods of shipping. The 0.001 cent per pound repre-

sents a cost disadvantage to the break-bulk method of shipping. This figure, however, does not include damage to the boxes or products and is not sufficient to make it worthwhile for the owner of the shipment to file a claim. Only two of the break-bulk test shipments arrived at their destination in good order; the others sustained a considerable amount of box damage.

It is common practice in the poultry trade for shippers and receivers to absorb small pilferage losses. Pilferage was prevalent in most of the break-bulk shipments but was not considered sufficient to justify filing a claim with the insurance company.

Physical damage to the boxes and the product was very prevalent during transfer of the shipments at the ports—from the over-the-road vehicle to the dock and from the dock to the refrigerated hold of the ship. Similar damage occurred at the overseas ports.

None of the damage or pilferage found in the break-bulk shipments occurred in the van container shipments. This is one of the principal reasons that most poultry exporters and importers now favor shipment by van container. Pilferage was not only common but apparently inevitable in all break-bulk shipments. A sealed container loaded at the plant and unloaded at the receiver's warehouse helps to insure good delivery without loss.

The total cost per pound of 17.37 cents (table 15) for the break-bulk shipments does not represent any great difference from the 17.91 cents for the van container shipments during this study (1966–69). With development of new containerization facilities, inland transport costs for van container shipments have been greatly reduced and hopefully insurance charges for these shipments will soon reflect the reduced shipping losses by this method of transport.

The advantages the poultry shipper looks for in containerization are not solely in the area of cost. Shippers of poultry to overseas markets are increasingly turning to the van container because of less damage to goods in transit, less pilferage, shorter transit times, reduced cost of packaging, and reduced inventory requirements.

The cost data on containerization developed in this study also point to additional advantages that should greatly assist the poultry shippers in getting their products to overseas markets in better condition and at a lower cost. An important characteristic of the van container system is its capital intensiveness in comparison to the excessive labor requirements of the break-bulk system. To operate economically the containership must have a high rate of utilization.

The high rate of utilization required by the containership is significant both to the carrier and to the poultry shipper. To the carriers the port costs (terminal operations and cargo handling) are cut in half. To the poultry shipper the transit time required for this shipment to reach his overseas customer is sharply reduced. To the poultry receiver his inventory requirements are dimished.

The capital inputs of the containership operators in refrigeration equipment, van containers, and chassis are sizable (tables 17–19). The ownership costs for equipment, being of a fixed nature, require that it be utilized intensively to obtain a satisfactory return on investment. To assure a profitable return on their capital investments, ocean carriers will have to exert maximum effort (1) to obtain a sufficient volume of traffic and (2) to coordinate container movement by sea as effectively as possible with schedules of connecting land carriers to obtain maximum use of their equipment.

APPENDIX

Voyage Expense

This category includes those expense items necessary for the daily operation of the ship and the ownership expenses attached thereto.

The cost figures shown as active expenses represent actual costs accumulated for each item listed during the specific voyage. They are directly related to the operation of the vessel.

Operating Expense.—Active vessel expense is synonymous with operating expense and includes those items incurred in having a cargo

ship provisioned, outfitted, manned, and ready to sail (table 11).

(1) Crew wages include straight-time wages, overtime wages, and fringe benefits.

(2) At-sea fuel expense includes both the bunker and diesel fuel consumed during the voyage.

(3) Subsistence expense consists of the total cost of feeding the ship's complement during the entire voyage.

(4) Stores and supplies expense relate to operating cost data covering the deck, engine, and stewards departments.

(5) Miscellaneous expense consists of operating cost data not subject to any other category.

(6) Repairs and maintenance expense incurred during the voyage pertains to the maintenance of the hull, machinery, and equipment.

(7) Marine insurance rates vary widely among ship operators and are dependent on fleet size, trade rates, company loss experience, and several other variables peculiar to management.

(a) Hull and machinery insurance includes insurance for both total and partial loss and excess liability coverage.

(b) War risk insurance in comparison to the expense for other forms of insurance is comparatively low and is dependent on world conditions.

(c) Shipper's insurance is cargo insurance with deductible provisions.

(d) Public liability and indemnity insurance provides coverage for the crew over deductible losses. Those costs below deductible losses are paid directly by the owner.

Capital Expense.—Capital expense is the second category under voyage expense and provides for capital-related costs, which are mainly depreciation and interest expense.

(1) Depreciation expense was calculated by customary straight-line depreciation over a 25-year life of the ship with a 5-percent provision for scrap value. The annual depreciation expense for each specific ship is computed on a daily basis, which then is increased by the number of days comprising the voyage to arrive at the depreciation expense per voyage. Table 20 (appendix) lists these expenses.

(2) Although interest expense is generally considered a capital expense item, the carriers in this study provided for this expense under the admininstrative and general expenses.

Inactive Vessel Expense.—This is the third and final category under voyage expense. It provides for allocating the expense that the ship incurs when it is not being utilized less the number of days the ship is laid up for repairs. This expense is customarily computed annually and then converted to a daily rate and finally to a voyage basis. Table 21 (appendix) lists the inactive vessel expense on a voyage basis.

Table 22 (appendix) lists the components of the voyage expense totaled and converted to a basis of cost per loaded van container. The cost per van container mile is computed from the total voyage expense divided by the loaded van container miles. The cost per van container mile is then multiplied by the nautical miles to arrive at the voyage cost per loaded van container.

Port Expense

The subdivisions under port expense are those used by the carriers in their accounting records and are based on geography, which is the normal criterion or basis for computing the various charges, rather than function.

Terminal Marine (Origin and Destination).—This expense is the annual rental charge to the carrier for pier, warehouse, and office facilities occupied by the carrier. The amount is determined by dividing the annual rental charge by the total tonnage, which gives a cost per ton.

Reefer Expense (Land and Sea).—This pertains to the voyage expense for operating, maintenance, and overhead of the refrigerated units of the van container. Table 18 (appendix) compares the total ownership and operating costs for a refrigerated van container on a voyage basis for both the land and the sea segments of the voyage. In addition to overhead and maintenance, the land section of this item provides for operating fuel and the at-sea section includes amortization of the ship's generator.

Chassis Expense (Land).—This is the owner-

ship and operating expenses incurred by the van container chassis used in hauling the van container to and from the containership. Table 19 (appendix) gives the total voyage expense of the ownership (depreciation) and operating costs (overhead and maintenance) of the van container chassis.

Container Award (U.S. Only).—This is a charge made by the longshoremen's union in the North and South Atlantic ports for each van container loaded or discharged. The rate in foreign and Puerto Rico trade is $1 per long ton and in domestic trade it is $0.28 per long ton.

Cargo Handling Expense

Cargo handling expense is those charges assessed against the ship as a result of entry, use of facilities, and clearance at port. These charges are for use of terminal facilities, including dockage and wharfage, as well as port service charges, dues, and taxes, such as port and harbor dues, pilotage, towage, tug hire, and various other services. The determination of these costs is somewhat complicated because the method and basis of computing the various charges differ from port to port.

Terminal Marine (Origin and Destination).—This includes most of the charges found under the general heading of port expense.

(1) Wages—payment to stevedores for loading and unloading cargo at the origin terminal. This includes overtime, payroll taxes, and welfare contributions or fringe benefits.

(2) Dockage—charges assessed for laying alongside a pier, shoreside power and other utilities, watchmen, and agency fees.

(3) Wharfage tariff—port costs assessed against a ship by some overseas ports as a result of entry, use of facilities, and clearance at port.

(4) Pilotage—charges assessed by a pilot for directing a vessel into and out of the port area.

(5) Tug hire—charges assessed for berthing a vessel and for moving it out of the pier area prior to sailing.

(6) Customs fees—payment of tonnage tax and navigation fees as required by respective countries of entry and exit.

(7) Handling lines—charge made in certain foreign ports for securing ship lines to the pier.

(8) Waterfront commissions—payment made to New York Port Authority for precautionary measures taken to promote security and prevent pilferage in the port area.

(9) Purchased stevedoring—charge made by a stevedoring company for loading and unloading ships in port.

(10) Crane services—payment for use of shoreside cranes in loading and unloading containers.

(11) Dunnage—charge made for security fastening and fastening container to vessel.

(12) Platform origin—expense of transferring a load into a van container arriving at an embarkation port from a railcar or over-the-road trailer.

Administrative and General Expenses

Under this category are the company overhead expense and such items as salaries, wages, legal and accounting fees, utilities, taxes, and interest expense due to the carrier's accounting practice. Also included are costs of overall management of shipping operations, as well as the cost of administration. This category is not directly related to the operation of one vessel, but these expenses must be allocated to vessel operations on an equitable basis (table 23).

TABLE 16.—*Costs of ownership and operation for certain materials-handling equipment in selected poultry processing plants, 1968*

Type of equipment	Initial cost [1]	Depreciation [2]	Annual ownership cost [3]	Insurance and taxes at 4 percent	Ownership cost	Annual operations cost			Ownership and operation costs	
						Gas, oil, and electricity [4]	Maintenance [5]	Total	Per year	Per hour [6]
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Straddle forklift truck (4,000-lb capacity, 36-V electric stand-up rider-type 153-in lift) with battery, 480–680 Ah, 17–20 kWh, and charger.	7,900	790	237.00	316	1,343.00	74	118.50	192.50	1,535.50	0.7678
Counter-balanced forklift truck (3,000-lb capacity, 200-in lift, gasoline).	7,900	790	237.00	316	1,343.00	274	395.00	669.00	2,012.00	1.0060
Counter-balanced forklift truck (2,000-lb capacity, 202-in lift, gasoline).	6,700	670	201.00	268	1,139.00	244	335.00	579.00	1,718.00	.8590
Straddle forklift truck (3,000-lb capacity, 36-V electric stand-up rider-type 453-in lift) with battery, 480–680 Ah, 17–20 kWh, and charger.	7,700	770	231.00	308	1,309.00	74	115.50	189.50	1,498.50	.7493
Counter-balanced forklift truck (4000-lb capacity, 202-in lift, gasoline).	8,800	880	264.00	352	1,496.00	305	440.00	745.00	2,241.00	1.1205
Pallet jack (4,000-lb capacity, 12-V electric walkie-type) with 450-A battery and charger.	3,050	305	91.50	122	518.50	28	45.75	73.75	592.25	.2961

[1] Based on 1968 manufacturers' estimates.

[2] 10-years' depreciation in accordance with U.S. Internal Revenue Service Bulletin "F" based on reasonable life expectancy.

[3] Computed interest is 6 percent per year for ½ equipment life calculated over full life.

[4] Power costs for battery charging of electric-powered vehicle computed from manufacturers' specifications.

[5] Computed at following percentages of interest cost when vehicles are used 2,000 hours per year: 1½ percent for electric forklift trucks, pallet forks; 5 percent for gas forklift trucks, 4-wheel selection truck.

[6] Based on 2,000 hours per year.

TABLE 17.—*Capital and labor inputs of refrigerated motor carriers extracted from ICC Form QFR-1 for 1967 and 1968*

Carrier No.	Capital input	Labor input	Truck and tractor distance operated in intercity freight	Capital cost per vehicle mile	Labor cost per vehicle mile	Total cost per vehicle mile
1967	*Dollars*	*Dollars*	*Miles*	*Dollars*	*Dollars*	*Dollars*
1	1,647,631	1,349,649	1,142,511	0.6051	0.0668	0.6719
2	691,405	76,378	6,528,871	.2523	.2067	.4590
3	2,525,697	249,519	4,261,749	.5926	.0585	.6511
4	18,360,436	5,799,407	41,762,566	.4396	.1388	.5784
5	1,974,096	710,621	7,789,529	.2534	.0912	.3446
6	124,418	153,899	106,784	1.1651	1.4412	2.6063
7	369,960	30,475	550,156	.6724	.0553	.7277
8	2,769,797	1,293,976	9,464,309	.2926	.1367	.4293
9	1,334,016	198,111	2,698,650	.4943	.0734	.5677
10	1,312,079	7,500	1,372,849	.9557	.0054	.9611
11	10,423,907	1,138,890	20,994,835	.4964	.0542	.5488
12	490,684	349,814	1,775,651	.2763	.1970	.4733
13	5,810,422	2,268,993	24,655,000	.2356	.0920	.3276
14	4,836,889	746,722	12,012,234	.4026	.0621	.4647
15	1,297,697	125,026	2,384,521	.5442	.0524	.5966
16	3,035,929	253,128	6,816,600	.4453	.0371	.4824
17	523,586	4,191,983	21,514,831	.3496	.1948	.5444
18	280,457	----	1,027,599	.2729	----	.2729
19	2,407,060	976,513	9,094,915	.2646	.1073	.3719
20	2,119,310	513,912	4,588,706	.4618	.1119	.5737
21	2,142,311	173,678	5,834,458	.3671	.0297	.3968
22	142,092	228,886	396,800	.3580	.5768	.9348
23	2,392,506	345,058	7,023,099	.3406	.0491	.3897
24	4,823,045	534,273	10,184,880	.4735	.0524	.5259
25	10,061,673	675,610	18,938,658	.5312	.0356	.5668
26	260,600	19,865	813,551	.3203	.0244	.3447
27	9,718,853	816,933	20,026,591	.4852	.0407	.5259
28	222,088	472,573	726,542	.3056	.6504	.9560
29	3,761,647	144,335	9,567,185	.3931	.0150	.4081
30	917,737	1,216,088	2,971,494	.3088	.4092	.7180
31	333,862	262,277	1,244,863	.2681	.2106	.4787
Average	----	----	----	[1].4257	[2].1648	.5905

1968

1	1,311,128	1,164,638	7,741,488	.1693	.1504	.3197
2	691,405	76,378	1,142,511	.6051	.0668	.6719
3	2,950,153	286,099	5,101,584	.5782	.0560	.6342
4	19,733,739	5,265,091	43,791,053	.4506	.1202	.5708
5	2,105,577	846,452	7,950,659	.2648	.1064	.3712
6	155,356	366,188	294,200	.5280	1.2446	1.7726
7	872,253	38,525	1,184,588	.7363	.0325	.7688
8	3,593,707	1,544,491	12,177,367	.2951	.1268	.4219
9	1,460,589	192,283	2,810,989	.5195	.0684	.5879
10	1,590,623	7,900	1,444,896	1.1008	.0054	1.1062
11	14,140,331	1,519,196	25,744,336	.5492	.0590	.6082
12	783,220	416,054	2,347,964	.3335	.2343	.5678
13	5,871,858	2,356,817	24,246,502	.2421	.0972	.3393
14	4,550,094	375,086	8,596,037	.5293	.0436	.5729
15	1,711,722	85,946	2,684,368	.6376	.0320	.6696
16	3,209,663	258,399	6,920,644	.4637	.0373	.5010
17	7,804,540	4,540,656	21,093,072	.3700	.2152	.5852
18	295,474	----	973,261	.3035	---	.3035
19	2,539,726	905,627	9,213,621	.2756	.0982	.3738
20	2,666,038	621,843	5,551,542	.4802	.1120	.5922
21	2,570,927	145,069	6,942,278	.3703	.0208	.3911
22	136,829	230,940	392,250	.3488	.5887	.9375
23	1,521,182	274,016	4,170,675	.3647	.0657	.4304
24	6,349,925	739,523	12,876,659	.4931	.0574	.5505
25	10,887,564	700,331	17,858,693	.6096	.0392	.6488
26	185,925	6,255	549,829	.3381	.0113	.3494
27	11,659,025	852,188	21,967,675	.5307	.0387	.5694
28	223,282	492,869	730,988	.3054	.6742	.9796
29	4,054,534	194,465	10,086,803	.4019	.0192	.4211
30	1,043,938	1,439,887	3,140,915	.3323	.4584	.7907
31	333,862	262,277	1,244,863	.2681	.2106	.4787
Total	----	----	----	13.7954	5.0905	18.8859
Average	----	----	----	[3].4311	[4].1590	.5901

[1] 72 percent of total cost.
[2] 28 percent of total cost.
[3] 73 percent of total cost.
[4] 27 percent of total cost.

TABLE 18.—*Ownership and operating costs for refrigerated van container test shipments of frozen poultry by voyage, 1966–69* [1]

Voyage	Utilization on—		Cost per day on land		Cost per day at sea		Total voyage cost per van container
	Land	Sea	Depreciation	Overhead and maintenance	Depreciation	Overhead and maintenance	
	Days	*Days*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
A	23	13	52.21	60.49	29.51	47.19	189.40
B	3	11	6.81	7.89	24.97	39.93	79.60
C	6	15	13.62	15.78	34.05	54.45	117.90
D	21	15	47.67	55.23	34.05	54.45	191.40
E	12	15	27.24	31.56	34.05	54.45	147.30
F	1	13	2.27	2.36	29.51	47.19	81.33
G	3	12	6.81	7.89	27.24	43.56	85.50
H	16	10	36.32	42.08	22.70	36.30	137.40

[1] Depreciation and overhead maintenance calculated by carrier at $2.27 and $2.63 per day, respectively.

TABLE 19.—*Ownership and operating costs for van container chassis used for test shipments of frozen poultry by voyage, 1966–69*

Voyage	Length of use	Cost per voyage		Total voyage cost per chassis
		Depreciation [1]	Overhead and maintenance [2]	
	Days	*Dollars*	*Dollars*	*Dollars*
A	23	12.19	34.04	46.23
B	3	1.59	4.44	6.03
C	6	3.18	8.88	12.06
D	21	11.13	31.08	42.21
E	12	6.36	17.76	24.12
F	1	.53	1.48	2.01
G	3	1.59	4.44	6.03
H	16	8.48	23.68	32.16

[1] Calculated by carrier at $0.53 per day.
[2] Calculated by carrier at $1.48 per day.

TABLE 20.—*Depreciation expense by voyage of van container used in test shipments, 1966–69*

Voyage	Daily depreciation	Length of voyage	Total depreciation
	Dollars	*Days*	*Dollars*
A	1,096	30	32,880
B	1,612	27	43,524
C	1,612	31	49,972
D	1,612	28	45,136
E	1,612	33	53,196
F	1,102	29	31,958
G	1,612	26	41,912
H	1,504	27	40,608

TABLE 21.—*Inactive and active vessel expenses by voyage of van container used in shipments, 1966–69*

Voyage	Inactive vessel expense	Expense per day of active use	Total active use	European active use	Total expense
	Dollars	*Dollars*	*Days*	*Days*	*Dollars*
B	17,542	49	358	247	12,103
C	18,258	51	358	202	10,302
D	29,110	82	355	110	9,020
E	51,303	147	349	320	47,040
F	57,510	1,278	45	27	34,506

TABLE 22.—*Expenses during test shipments of U.S. frozen poultry overseas by voyage and by loaded van container, 1966–69*

Voyage	Voyage expense				Loaded van container		Nautical distance (origin to destination)	Cost per loaded container
	Operating	Capital	Inactive	Total	Total distance	Cost per mile		
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Miles*	*Cents*	*Miles*	*Dollars*
A	108,422	32,880	4,410	145,712	1,541,303	0.0945	3,729	352
B	88,788	43,524	1,323	133,635	627,045	.2131	3,488	743
C	101,209	49,972	1,581	152,762	1,149,236	.1329	3,488	464
D	98,181	45,136	1,372	144,689	1,507,254	.0960	3,729	358
E	114,566	53,196	1,617	169,379	1,453,768	.1165	3,488	406
F	92,325	31,958	----	124,283	1,958,923	.0634	3,729	236
G	79,514	41,912	2,132	123,558	407,158	.3035	3,729	1,132

TABLE 23.—*Capital and labor inputs for ocean transport of selected test shipments of U.S. frozen*

Shipment and cost elements	Van container [1]					
			Capital		Labor	
	Capital and labor inputs	Percentage of total capital and labor inputs	Input [3]	Percentage of total capital and labor inputs	Input [3]	Percentage of total capital and labor inputs
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Shipment 1 (1967)[5]						
Voyage expense [6]	251.00	34.39	169.17	23.18	81.83	11.21
Terminal marine (origin)	36.18	4.95	28.14	3.85	8.04	1.10
Terminal marine (destination)	67.35	9.22	45.64	6.25	21.71	2.97
Reefer expense (land)	78.40	10.74	52.16	7.15	26.24	3.59
Reefer expense (sea)	59.00	8.08	38.20	5.23	20.80	2.85
Chassis expense (land)	32.16	4.41	8.48	1.17	23.68	3.24
Container award (U.S. only)	14.68	2.01	14.68	2.01	----	----
Land terminal (origin)	14.19	1.94	14.19	1.94	----	----
Land terminal (destination)	11.55	1.58	11.55	1.58	----	----
Administrative and general	165.33	22.65	115.73	15.86	49.60	6.79
Total	729.84	99.97	497.94	68.22	231.90	31.75
Shipment 2 (1967)[7]						
Voyage expense [6]	464.00	46.69	310.88	31.28	153.12	15.41
Terminal marine (origin)	42.07	4.23	24.06	2.42	18.01	1.81
Terminal marine (destination)	134.29	13.51	79.41	7.99	54.88	5.52
Reefer expense (land)	29.40	2.96	19.56	1.97	9.84	.99
Reefer expense (sea)	88.50	8.90	57.30	5.77	31.20	3.14
Chassis expense (land)	12.06	1.21	3.18	.32	8.88	.89
Container award (U.S. only)	11.71	1.18	11.71	1.18	----	----
Land terminal (origin)	12.93	1.39	12.93	1.30	----	----
Land terminal (destination)	66.66	6.71	66.66	6.71	----	----
Administrative and general	132.26	13.31	92.26	9.28	40.00	4.02
Total	993.88	100.00	677.95	68.22	315.93	31.78
Shipment 3 (1968)[8]						
Voyage expense [6]	352.00	40.72	236.00	27.30	116.00	13.42
Terminal marine (origin)	53.05	6.14	28.06	3.25	24.99	2.89
Terminal marine (destination)	42.22	4.88	30.94	3.50	11.28	1.30
Reefer expense (land)	112.70	13.03	74.98	8.67	37.72	4.36
Reefer expense (sea)	76.70	8.87	49.66	5.74	27.04	3.13
Chassis expense (land)	46.23	5.35	12.19	1.41	34.04	3.94
Container award (U.S. only)	12.55	1.45	12.55	1.45	----	----
Land terminal (origin)	12.11	1.40	12.11	1.40	----	----
Land terminal (destination)	15.79	1.83	15.79	1.83	----	----
Administrative and general	141.18	16.33	98.83	11.43	42.35	4.90
Total	846.53	100.00	571.11	66.06	293.42	33.94

See footnotes at end of table.

poultry by van container and break-bulk systems, New York to Rotterdam, 1967–68

Capital and labor inputs	Percentage of total capital and labor inputs	Break-bulk [2]			
		Capital		Labor	
		Input [4]	Percentage of total capital and labor inputs	Input [4]	Percentage of total capital and labor inputs
Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
302.05	38.36	127.80	16.23	174.25	22.13
238.05	30.23	101.34	12.87	136.71	17.36
85.56	10.87	27.13	3.45	58.43	7.42
1.55	.20	.91	.12	.64	.08
2.47	.31	.93	.12	1.54	.20
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15.01	1.91	15.01	1.91	----	----
39.61	5.03	22.88	2.91	16.73	2.12
15.88	2.02	15.88	2.02	----	----
87.30	11.09	45.78	5.81	41.52	5.27
787.48	100.02	357.66	45.44	429.82	54.58
409.12	41.47	152.48	15.45	256.64	26.01
266.94	27.06	124.69	12.64	142.25	14.42
103.90	10.53	54.32	5.51	49.58	5.03
1.31	.13	.99	.10	.32	.03
1.80	.18	1.00	.10	.80	.08
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35.63	3.61	23.99	2.43	11.64	1.18
45.04	4.57	45.04	4.57	----	----
122.87	12.45	55.77	5.65	67.10	6.80
986.61	100.00	458.28	46.45	528.33	53.55
259.47	37.36	115.71	16.66	143.76	20.70
224.96	32.40	84.91	12.23	140.05	20.17
71.16	10.25	12.91	1.86	58.25	8.39
1.16	.17	.81	.12	.35	.05
1.70	.25	.82	.12	.88	.13
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----	----	----	----	----	----
40.01	5.76	21.09	3.04	18.92	2.72
12.63	1.81	12.63	1.81	----	----
83.32	12.00	36.92	5.32	46.40	6.68
694.41	100.00	285.80	41.16	408.61	58.84

TABLE 23.—*Capital and labor inputs for ocean transport of selected test shipments of U.S. frozen*

Shipment and cost elements	Van container [1]					
			Capital		Labor	
	Capital and labor inputs	Percentage of total capital and labor inputs	Input [2]	Percentage of total capital and labor inputs	Input [2]	Percentage of total capital and labor inputs
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Shipment 4 (1968) [9]						
Voyage expense [6]	358.00	36.52	239.86	24.47	118.14	12.05
Terminal marine (origin)	42.97	4.38	31.58	3.22	11.39	1.16
Terminal marine (destination)	81.58	8.32	40.67	4.15	40.91	4.17
Reefer expense (land)	102.90	10.50	68.46	6.98	34.44	3.52
Reefer expense (sea)	88.50	9.03	57.30	5.85	31.20	3.18
Chassis expense (land)	42.21	4.31	11.13	1.14	31.08	3.17
Container award (U.S. only)	14.60	1.49	14.60	1.49	----	----
Land terminal (origin)	16.07	1.64	16.07	1.64	----	----
Land terminal (destination)	68.55	6.99	68.55	6.99	----	----
Administrative and general	164.82	16.81	115.37	11.77	49.45	5.04
Total	980.20	99.99	663.59	67.70	316.61	32.29
Shipment 5 (1968) [10]						
Voyage expense [6]	406.00	40.81	272.02	27.34	133.98	13.47
Terminal marine (origin)	41.50	4.17	32.56	3.27	8.94	.90
Terminal marine (destination)	78.57	7.90	42.73	4.30	35.84	3.60
Reefer expense (land)	58.80	5.91	39.12	3.93	19.68	1.98
Reefer expense (sea)	88.50	8.90	57.30	5.76	31.20	3.14
Chassis expense (land)	24.12	2.43	6.36	.64	17.76	1.79
Container award (U.S. only)	15.60	1.57	15.60	1.57	----	----
Land terminal (origin)	17.15	1.72	17.15	1.72	----	----
Land terminal (destination)	88.37	8.88	88.37	8.88	----	----
Administrative and general	176.18	17.71	123.32	12.40	52.86	5.31
Total	994.79	100.00	694.53	69.81	300.26	30.19
Shipment 6 (1968) [11]						
Voyage expense [6]	1,132.00	62.15	758.44	41.64	373.56	20.51
Terminal marine (origin)	97.61	5.36	54.67	3.00	42.94	2.36
Terminal marine (destination)	207.16	11.37	100.00	5.49	107.16	5.88
Reefer expense (land)	14.70	.81	9.78	.54	4.92	.27
Reefer expense (sea)	70.81	3.89	45.85	2.52	24.96	1.39
Chassis expense (land)	6.03	.33	1.59	.09	4.44	.24
Container award (U.S. only)	16.22	.89	16.22	.89	----	----
Land terminal (origin)	17.83	.98	17.83	.98	----	----
Land terminal (destination)	76.04	4.18	76.07	4.18	----	----
Administrative and general	183.11	10.06	110.86	6.09	72.25	3.97
Total	1,821.54	100.02	1,191.31	65.42	630.23	34.60

See footnotes at end of table.

poultry by van container and break-bulk systems, New York to Rotterdam, 1967–68—Continued

Break-bulk [2]					
		Capital		Labor	
Capital and labor inputs	Percentage of total capital and labor inputs	Input [4]	Percentage of total capital and labor inputs	Input [4]	Percentage of total capital and labor inputs
Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
560.96	56.15	202.84	20.30	358.12	35.85
193.31	19.35	56.92	5.70	136.39	13.65
86.13	8.63	33.72	3.38	52.41	5.25
2.12	.22	1.26	.13	.86	.09
3.43	.34	1.29	.13	2.14	.21
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22.61	2.26	16.13	1.61	6.48	.65
24.01	2.40	24.01	2.40	--	----
106.44	10.65	52.82	5.29	53.62	5.36
999.01	100.00	388.99	38.94	610.02	61.06
694.11	58.06	265.12	22.18	428.99	35.88
216.15	18.08	68.38	5.72	147.77	12.36
114.83	9.60	54.16	4.53	60.67	5.07
2.51	.21	1.53	.13	.98	.08
4.02	.34	1.57	.13	2.45	.21
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24.94	2.08	15.94	1.33	9.00	.75
24.10	2.02	24.10	2.02	----	----
114.85	9.61	51.79	4.33	63.06	5.28
1,195.51	100.00	482.59	40.37	712.92	59.63
317.50	42.13	117.04	15.53	200.46	26.60
219.52	29.13	85.28	11.32	134.24	17.81
115.98	15.39	48.83	6.48	67.15	8.91
1.10	.14	.79	.10	.31	.04
1.58	.21	.80	.11	.78	.10
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20.21	2.68	13.88	1.84	6.33	.84
11.87	1.58	11.87	1.58	----	----
65.90	8.74	39.51	5.24	26.39	3.50
753.66	100.00	318.00	42.20	435.66	57.80

TABLE 23.—*Capital and labor inputs for ocean transport of selected test shipments of U.S. frozen*

Shipment and cost elements	Van container[1]					
			Capital		Labor	
	Capital and labor inputs	Percentage of total capital and labor inputs	Input[3]	Percentage of total capital and labor inputs	Input[3]	Percentage of total capital and labor inputs
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Shipment 7 (1968)[12]						
Voyage expense[6]	743.00	50.08	496.71	33.48	246.29	16.60
Terminal marine (origin)	96.36	6.49	50.34	3.39	46.02	3.10
Terminal marine (destination)	254.10	17.13	145.93	9.84	108.17	7.29
Reefer expense (land)	14.70	.99	9.78	.66	4.92	.33
Reefer expense (sea)	64.90	4.37	42.02	2.83	22.88	1.54
Chassis expense (land)	6.03	.41	1.59	11	4.44	.30
Container award (U.S. only)	16.01	1.08	16.01	1.08	----	----
Land terminal (origin)	17.54	1.18	17.54	1.18	----	----
Land terminal (destination)	90.39	6.09	90.39	6.09	----	----
Administrative and general	180.70	12.18	126.49	8.53	54.21	3.65
Total	1,483.73	100.00	996.80	67.19	486.93	32.81
Shipment 8 (1968)[13]						
Voyage expense[6]	236.00	34.17	158.12	22.89	77.88	11.28
Terminal marine (origin)	40.76	5.91	30.36	4.40	10.40	1.51
Terminal marine (destination)	61.15	8.85	36.49	5.28	24.66	2.57
Reefer expense (land)	4.90	.71	3.26	.47	1.64	.24
Reefer expense (sea)	76.70	11.10	49.66	7.19	27.04	3.91
Chassis expense (land)	2.01	.29	.53	.08	1.48	.21
Container award (U.S. only)	14.89	2.16	14.89	2.16	----	----
Land terminal (origin)	16.36	2.37	16.36	2.37	----	----
Land terminal (destination)	69.80	10.11	69.80	10.11	----	----
Administrative and general	168.14	24.34	117.70	17.04	50.44	7.30
Total	690.71	100.01	497.17	71.99	193.54	28.02

[1] Data obtained from carrier's records on specific voyage cost basis. Allocations for general cost items made by carrier.

[2] Data obtained from MAR Forms 172 and 600–6 filed by carrier with Maritime Administration. Information synthesized from total carriers cargo voyages for year based on total freight payable tons carried.

[3] Represents voyage expense per container.

[4] Represents cost for 16-ton shipping unit comparable to van container shipment.

[5] 681 loaded van containers; $0.0720 per mile; $101,124 per voyage; $250 per loaded van container; $988.91 per loaded van container (total cost).

[6] Equal to sum of active and inactive vessel expenses and capital expense.

[7] 317 loaded van containers; $0.1329 per mile; $101,209 per voyage; $464 per loaded van container; $913.17 per loaded van container (total cost). Freight payable tons carried during year—3,000,815.

poultry by van container and break-bulk systems, New York to Rotterdam, 1967–68—Continued

Break-bulk [2]					
		Capital		Labor	
Capital and labor inputs	Percentage of total capital and labor inputs	Input [4]	Percentage of total capital and labor inputs	Input [4]	Percentage of total capital and labor inputs
Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
366.26	43.53	132.13	15.70	234.13	27.83
206.80	24.58	83.67	9.94	123.13	14.64
111.25	13.23	67.94	8.08	43.31	5.15
.99	.11	.70	.08	.29	.03
1.42	.16	.71	.08	.71	.08
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15.04	1.79	12.20	1.45	2.84	.34
24.91	2.96	24.91	2.96	----	----
114.66	13.63	42.90	5.10	71.76	8.53
841.33	99.99	365.16	43.39	476.17	56.60
479.83	51.40	198.57	21.27	281.26	30.13
221.63	23.74	92.36	9.89	129.27	13.85
98.92	10.60	53.16	5.70	45.76	4.90
1.73	.19	1.19	.13	.54	.06
2.57	.28	1.21	.13	1.36	.15
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----	----	----	----	----	----
21.45	2.30	13.42	1.44	8.03	.86
19.94	2.14	19.94	2.14	----	----
87.41	9.36	38.63	4.14	48.78	5.22
933.48	100.01	418.48	44.84	515.00	55.17

[8] 428 loaded van containers; $0.0945 per mile; $101,209 per voyage; $452.50 per loaded van container; $989.72 per loaded van container (total cost). Freight payable tons carried during year—3,572,706.

[9] 462 loaded van containers; $0.0960 per mile; $98,181 per voyage; $358 per loaded van container; $969.29 per loaded van container (total cost). Freight payable tons carried during year—2,198,978.

[10] 411 loaded van containers; $0.1165 per mile; $114,506 per voyage; $406 per loaded van container; $1,252.51 per loaded van container (total cost).

[11] 113 loaded van containers; $0.3035 per mile; $123,558 per voyage; $1,132 per loaded van container; $1,721.53 per loaded van container (total cost).

[12] 171 loaded van containers; $0.2131 per mile; $133,635 per voyage; $743 per loaded van container; $1,484.73 per loaded van container (total cost).

[13] 538 loaded van containers; $0.0634 per mile; $124,283 per voyage; $236 per loaded van container; $669.88 per loaded van container (total cost).

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