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An Economic Analysis of Interregional Competition in the Frozen Pea Industry

Agricultural Experiment Station
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In cooperation with
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Foreword

This report is the sixth in a series dealing with costs and efficiencies in the pea freezing industry. The other five publications are as follows:

Costs and Efficiencies in Pea Freezing Operations, Part I—Vining, G. B. Davis, and H. M. Hutchings, Oregon Agricultural Experiment Station Miscellaneous Paper No. 66, January 1959.

Costs and Efficiencies in Pea Freezing Operations, Part II—Packaging and Freezing, G. B. Davis, and H. M. Hutchings, Oregon Agricultural Experiment Station Miscellaneous Paper No. 87, March 1960.

How to Improve Operating Efficiency in Food Processing Plants, H. M. Hutchings, and G. B. Davis, Oregon Agricultural Experiment Station Miscellaneous Paper No. 77, August 1959.

Estimated Costs of Producing Green Peas in Major Pea Freezing Areas of United States, H. M. Hutchings, and G. B. Davis, Oregon Agricultural Experiment Station Circular of Information 601, February 1960.

Some Aspects of the Competitive Position of the Northwest Frozen Pea Industry—A Progress Report, H. M. Hutchings, and G. B. Davis, Oregon Agricultural Experiment Station Miscellaneous Paper No. 113, May 1961.

These studies have been made under a regional project concerned with the marketing of frozen fruits and vegetables. Experiment stations in Oregon, California, Washington, and Hawaii and the Economic Research Service of the United States Department of Agriculture are cooperating in this program.

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Contents

An Economic Analysis of Interregional Competition in the Frozen Pea Industry

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Introduction

Production of green peas for freezing has more than doubled in the past decade. This increase has resulted from changes in the characteristics of both demand and supply. On the demand side, growth in population, increasing per capita incomes, increasing consumer preference for the frozen product, and more and better home refrigeration facilities have been contributing factors. During this 10-year period per capita consumption of frozen peas has increased almost 100% while that of canned peas has remained about constant and fresh pea consumption has dropped to about one-third of its 1949 level.

On the supply side, technological advances in farm production, processing, and freezing of peas as well as improvement of transportation, storage, and distribution facilities have contributed to the growth and expansion of the industry. This growth in production has taken place in all areas of the country producing peas for freezing, but the West has experienced the largest increase. It now produces about 70% of the national supply, with the heaviest concentration in the Pacific Northwest.

The northwest pea industry is unique with respect to both production and markets. Production is a large scale operation often consisting of several hundred acres of peas per farm. The product is marketed nationally, and much of it is shipped to the more populated areas of the East. As a consequence, transportation costs are considerably higher per unit of product than for other competing regions. Prevailing wage rates and transportation costs for incoming supplies and equipment also are higher. In spite of these cost disadvantages, the northwest pea industry has expanded rapidly and now provides a large portion of the national supply of frozen peas.

It is important to understand the reasons why such increases in production take place at a more rapid rate in some areas than in others. Management in the industry is guided by important economic considerations which over the long run dictate where production can best take place. Future locational development of the pea industry depends on the comparative advantage of different regions in producing and processing frozen peas. This is important to producers and processors in making future plans and investments.

This study attempts to quantify economic considerations that affect the northwest pea industry's ability to compete with other regions producing and processing frozen peas. An effort also is made to improve upon the methodology of interregional competition analyses.

Specific objectives of this study are divided into two groups:

1. Objectives with direct application to interregional competition in the frozen pea industry.
   - To determine supply, demand, and price relationships for frozen peas as related to major producing and consuming regions.
   - To determine the competitive position of the major pea-freezing areas of the United States.
   - To project an efficient pattern of growth for this industry.
2. Objectives concerning methodology.
   - To develop refinements and improvements in spatial equilibrium models used in analyses of interregional competition which will permit the incorporation of regional demand and supply functions.
   - To eliminate some of the limitations of past empirical research in this area through utilization of more complete, accurate, and reliable data.
   - To demonstrate the effect of restrictive assumptions concerning demand and supply elasticities upon interregional competition analysis.

Review of Literature

Location of production and interregional competition have been subjects of interest for many years, dating back to Adam Smith's (68) principle of specialization and David Ricardo's (62) principle of comparative costs. Their work led to the principle of comparative advantage which states: Each area tends to produce those products for which its ratio of advantage is greatest as compared with other areas, or its ratio of disadvantage is the least.

The early English economists abstracted from transportation costs and consequently did not deal with their effect upon interregional trade. It was Von Thünen (33) in 1826 and Alfred Weber (84) in 1909 who concerned themselves with the influence of transportation costs and developed the location principle.

In the first volume of his *Isolated State* Von Thünen assumed a land of homogeneous fertility with one city in the center, so that different locations would be distinguished only by differences in the cost of transporting the crop to market. By this means, he pointed out that the different branches of agriculture will situate themselves in concentric rings around the city in order of decreasing intensiveness of cultivation, interrupted only in cases where the crop is bulky or perishable.

Von Thünen's approach to the problem of the best location of agricultural production served as a model 80 years later for Alfred Weber's inquiry into the problem of the best location for industries. He found that it was determined by the weight of materials and products to be transported and by the location of materials and skilled labor.

The work of Von Thünen and Weber is still being used as the basis for recent theoretical treatments of location economics by Lösch (54) and Isard (40) (41). These more recent works emphasize locating borders of raw materials supply areas and product distribution areas and the effect of irregularities of the transport network and discontinuities in transport costs on location of production.

Heady (28) points out that the degree and the nature of specialization found in different geographic areas are dependent on two sets of relationships: (1) Regional production possibility relationships (i.e., regional transformation curves) establish the physical opportunities which are open to a particular region and these depend upon the production function for each individual commodity and for each firm. Production possibilities available to particular regions depend upon climate, soil, and biological factors. (2) Patterns of production and resource use differ among regions because of regional variations in the ratio of prices of product to prices of factors of production, the ratio of prices of products to prices of other products, and the ratio among prices of factors of production.

Theoretical Development of Spatial Equilibrium Models

Contributions cited above are of a qualitative rather than quantitative nature and consequently do not lend themselves to empirical research. More recent contributions, however, have been directed toward the development of a methodological framework for empirical research. Koopmans (50), Samuelson (63), Baumol (2), and Enke (18) have suggested new approaches to the problem of geographical price equilibrium and flows. They have used linear programming techniques developed from the more general macro input-output model of Leontief (53).

The transportation problem of linear programming is the more simple form of the spatial equilibrium model. It has been applied successfully to problems involving the shipment of specified quantities of a commodity from each of a number of sources and the receipt of specified quantities at each of a number of destinations, with total receipts being equal to total shipments.

The transportation problem can be expressed algebraically as follows:

Objective is to minimize

$$f_{(c)} = \Sigma_i \Sigma_j T_{ij} A_{ij}$$

subject to these restraints

$$\Sigma_i A_{ij} = X_i$$
$$\Sigma_j A_{ij} = Y_j$$
$$A_{ij} \geq O$$
$$\Sigma_i X_i = \Sigma_j Y_j$$

where

X_i = quantity or fixed stock of a homogeneous product available at *ith* supply point.

Y_j = quantity of a homogeneous product required at *jth* destination.

T_{ij} = unit cost of transporting product from *ith* supply point to *jth* destination.

A_{ij} = quantity of product transported from *ith* supply point to the *jth* destination.

If there are *m* deficit (consumption) regions and *n* surplus (production) regions, the information when placed in the form of matrices would appear as in Tables 1 and 2. The symbols have the same meaning as given above.

The transportation problem, as described above, is limited in its range of usefulness as a spatial equilibrium model because quantities offered and taken are fixed and inelastic with respect to price. This makes the model extremely short-run in nature.

Certain modifications have given this analytical model a wider range of applicability. For example, instead of minimizing only transportation costs, the model can be expanded to include other costs—costs of production, processing, and selling which must be considered in pricing the product at its origin. If it is assumed that these prices are not a function of output, the transportation model can still be used by simply adding the costs of producing, processing, and selling each unit at the *ith* origin to T_{ij} (the cost of transporting a unit of the product from the *ith* origin to the *jth* destination). This, however, would be useless as long as regional production is fixed and

Table 1. Distribution matrix in transportation model of linear programming

Producing regions	Consuming regions					Total regional production
	1	2	3	....	m	
1	A_{11}	A_{12}	A_{13}	....	A_{1m}	$\Sigma_m A_{1m}$
2	A_{21}	A_{22}	A_{23}	....	A_{2m}	$\Sigma_m A_{2m}$
3	A_{31}	A_{32}	A_{33}	....	A_{3m}	$\Sigma_m A_{3m}$
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
n	A_{n1}	A_{n2}	A_{n3}	....	A_{nm}	$\Sigma_m A_{nm}$
Total regional consumption	$\Sigma_n A_{n1}$	$\Sigma_n A_{n2}$	$\Sigma_n A_{n3}$	....	$\Sigma_n A_{nm}$	$\Sigma_n \Sigma_m A_{nm}$

Table 2. Transfer cost matrix in transportation model of linear programming

Producing regions	Consuming regions				
	1	2	3	....	m
1	T_{11}	T_{12}	T_{13}	....	T_{1m}
2	T_{21}	T_{22}	T_{23}	....	T_{2m}
3	T_{31}	T_{32}	T_{33}	....	T_{3m}
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
n	T_{n1}	T_{n2}	T_{n3}	....	T_{nm}

total production is equal to total consumption. The objective of including these other costs would be to determine a minimum cost *production and shipment* pattern instead of only a minimum cost *shipment* pattern.

Another modification, therefore, is necessary to develop a wider range of applicability. The equality ($\Sigma_i X_i = \Sigma_j Y_j$) must be made an inequality ($\Sigma_i X_i > \Sigma_j Y_j$) in order to determine an efficient pattern of production. In such cases where given supplies are assumed to exceed demands, a dummy requirement or destination, $m + 1$, can be created to transform the inequalities back into equalities. The fictitious region $m + 1$ absorbs all of the excess production of the supplying regions. The cost of supplying the dummy destination would be set equal to M, where M is a very large number, and represents shipments that would be fulfilled only after all other requirements have been satisfied.

The practical interpretation of this problem with the added modification now is somewhat changed. Before, it was assumed that the point estimate of fixed production in each supplying region was on a perfectly inelastic supply function. With the changes described above, potential production in each region is considered with the point estimate of costs (constant supply price) on a perfectly elastic supply function. The interpretation of the consuming regions is the same as before, except that the dummy region absorbs all excess supplies with the lowest cost production going to satisfy the needs of the other consuming regions.

The modified transportation model still is limited because of the assumptions of perfect elasticity of supply and inelasticity of demand.

A more general equilibrium model has been developed in order to consider the effect of price upon production and consumption in the various regions. It differs from the simpler transportation model in that quantity offered and quantity taken are entered as continuous functions dependent upon commodity price. This permits the results to be of "longer-run" value.

The theoretical framework for this more general model has largely been developed by Enke (18) and Samuelson (63). Enke states the spatial equilibrum problem for a single commodity as follows:

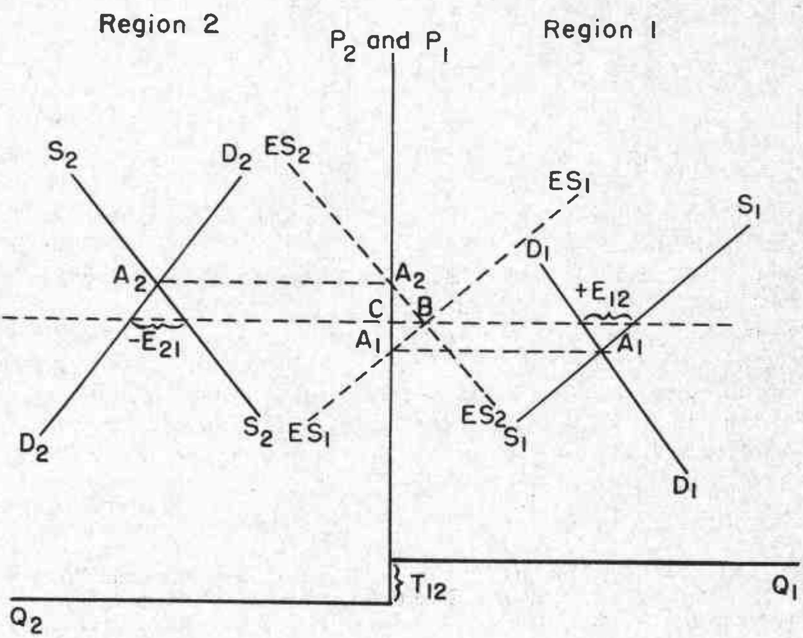
> "There are three or more regions trading a homogeneous good. Each region constitutes a single and distinct market. The regions of each possible pair of regions are separated but not isolated by a transportation cost per physical unit which is independent of volume. There are no legal restrictions to limit the actions of profit seeking traders in each region. For each region the functions which relate local production and local use to local price are known, and consequently the magnitude of the difference which will be exported or imported at each local price is

> also known. Given these trade functions and transportation costs, we wish to ascertain: (1) the net price in each region, (2) the quantity of exports or imports for each region, (3) which regions export, import or do neither, (4) the aggregate trade in the commodity, (5) the volume and direction of trade between each possible pair of regions."

Enke showed that this problem could be solved by "a relatively simple electric circuit." Samuelson treated the same problem on a strictly mathematical basis and demonstrated how it could be converted into a maximizing problem. He also related the Enke problem to the so-called Koopmans-Hitchcock minimum-transportation problem.

Samuelson develops the two-region case graphically by using the conventional textbook back-to-back diagram determining the equilibrium flow of exports from market 1 to market 2 (Figure 1). Before trade, the equilibrium price would be at A_1 in Region 1 and at A_2 in Region 2 where the regional supply and demand curves just

Figure 1. Determination of equilibrium prices and product flows in the two-region competitive case using a back-to-back diagram with positive transportation costs.



meet. Because the equilibrium price without trade in Region 1 is lower than that in Region 2, goods will obviously flow from Region 1 to Region 2 if the difference in price exceeds the transportation costs from Region 1 to Region 2 (T_{12}). Trade will take place until the price in Region 2 exceeds the price in Region 1 by exactly T_{12}. For this reason the axes of Region 1 have been offset vertically, relative to those of Region 2 by the distance T_{12}. Thus any horizontal line on the back-to-back diagram represents prices in the two markets differing by exactly the amount of transportation costs.

With the direction of trade established, excess supply curves are plotted to show the amount of product that will be shipped from Region 1 to Region 2. These functions, ES_1 and ES_2, are determined by subtracting the quantity taken from the quantity offered at every price. In other words, these curves show the amounts by which the quantities offered for sale in the region exceed the quantities taken at various prices. The combined market equilibrium price is located at B, where the excess supply of Region 1 exactly equals the deficiency in supply of Region 2, that is $E_{12} = -E_{21} = CB$ in Figure 1. If the difference between A_1 and A_2 (the equilibrium prices without trade) had been less than T_{12}, the markets would have remained isolated and separate equilibrium prices would prevail at A_1 and A_2.

From this two-region case, Samuelson went on to develop the n region case in terms of linear programming.

Empirical Studies of Interregional Competition

Recent empirical efforts to develop spatial models in agriculture have been patterned after the theoretical models discussed above.[1] Some of these studies have assumed both regional supplies (production) and regional demands (consumption) as given or predetermined. Others have begun with predetermined production but have utilized an estimated demand function in estimating consumption. The objective of both of these classes of problems has been to solve for the pattern of shipments that would result in minimizing transportation costs.

A third group of studies has assumed given amounts of regional consumption and has utilized some type of supply function to solve

[1] See Fox (25), Fox and Taeuber (24), Judge (43), Judge and Wallace (46), Dennis (14), Heady and Egbert (31), Henry and Bishop (35), and Snodgrass and French (70).

for the minimum cost pattern of production which would supply the predetermined amounts of consumption. By and large these studies have estimated single value supply prices and have assumed perfectly elastic supply functions.[2] The authors know of no studies of a single commodity that have incorporated both quantity offered and quantity taken as functions of price.

Analytical Framework

Many of the empirical studies made to date have been criticized as being unrealistic because of the simplifying assumptions made relative to demand and supply. The recent theoretical development of spatial models by Samuelson and others has demonstrated the importance of the role of demand and supply in this type of analysis. It is for this reason that a serious effort is made here to bring both of these relationships explicitly into the analysis and to eliminate some of the more restrictive assumptions made in past empirical studies of interregional competition.

Two different models are used in the present analysis of the frozen pea industry. Both models utilize regional demand and supply functions in an expanded and modified version of the transportation problem of linear programming. The first is a cost minimizing model and the second, a maximization model. These are explained in more detail below.

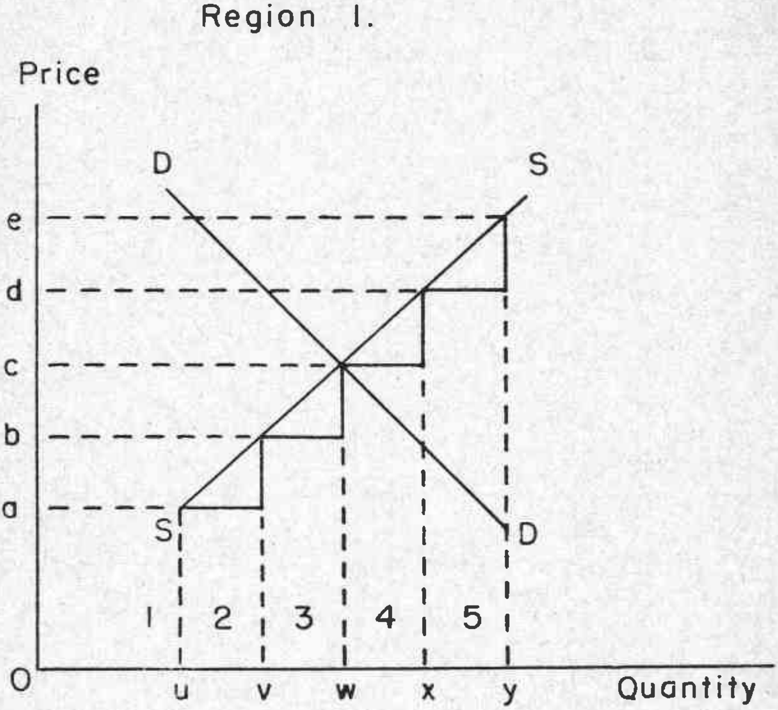
Model I

This model utilizes the demand function "outside" the linear programming framework. Regional consumption estimates have been computed from approximated regional demand schedules for assumed conditions and price levels and have been entered into the transportation model.

The supply function is treated somewhat differently. Approximated regional supply functions are segmented into "steps." Figure 2 shows that the quantity supplied is a function of price and that Step 1 of Region 1 will supply *Ou* quantity at *Oa* price. Step 2 will

[2] Dennis in his study of interregional competition of the frozen strawberry industry has attempted to overcome the limitations of the assumption of perfectly elastic supply functions through a series of regional supply restrictions (14).

Figure 2. A segmented regional supply curve as it approximates a continuous function.



supply an additional *uv* quantity at higher price, *Ob,* Step 3, additional quantity *vw* at *Oc* price, and so forth.[3]

Instead of entering each production region into the transportation problem matrices only once as shown in Table 1, each step is entered and a new expanded matrix is formed as shown in Table 3 where again there are *n* producing regions and *m* consuming regions but each producing region is broken into a, b, c, d, and e "steps" or "segments."

[3] This does not imply that these "steps" or "segments" of the supply schedule are to be geographical in nature. Supply curves slope upward and to the right within a region for the following reasons; (1) Land and other factors of a lower quality are brought into production as the quantity produced is increased; and (2) the employment of more units of the factors bids up the price of these factors in order to draw them away from alternative uses.

Table 3. Distribution matrix in the modified transportation model of linear programming

Producing region	Supply segment	Consuming regions 1	2	3	....	m	Dummy (m+1)	Total regional production
	a	$A_{1a,1}$	$A_{1a,2}$	$A_{1a,3}$	....	$A_{1a,m}$	$A_{1a,(m+1)}$	$\Sigma_m A_{1a,m}$
	b	$A_{1b,1}$	$A_{1b,2}$	$A_{1b,3}$	....	$A_{1b,m}$	$A_{1b,(m+1)}$	$\Sigma_m A_{1b,m}$
1	c	$A_{1c,1}$	$A_{1c,2}$	$A_{1c,3}$	....	$A_{1c,m}$	$A_{1c,(m+1)}$	$\Sigma_m A_{1c,m}$
	d	$A_{1d,1}$	$A_{1d,2}$	$A_{1d,3}$	....	$A_{1d,m}$	$A_{1d,(m+1)}$	$\Sigma_m A_{1d,m}$
	e	$A_{1e,1}$	$A_{1e,2}$	$A_{1e,3}$	....	$A_{1e,m}$	$A_{1e,(m+1)}$	$\Sigma_m A_{1e,m}$
	a	$A_{2a,1}$	$A_{2a,2}$	$A_{2a,3}$	....	$A_{2a,m}$	$A_{2a,(m+1)}$	$\Sigma_m A_{2a,m}$
	b	$A_{2b,1}$	$A_{2b,2}$	$A_{2b,3}$	....	$A_{2b,m}$	$A_{2b,(m+1)}$	$\Sigma_m A_{2b,m}$
2	c	$A_{2c,1}$	$A_{2c,2}$	$A_{2c,3}$	....	$A_{2c,m}$	$A_{2c,(m+1)}$	$\Sigma_m A_{2c,m}$
	d	$A_{2d,1}$	$A_{2d,2}$	$A_{2d,3}$	....	$A_{2d,m}$	$A_{2d,(m+1)}$	$\Sigma_m A_{2d,m}$
	e	$A_{2e,1}$	$A_{2e,2}$	$A_{2e,3}$	....	$A_{2e,m}$	$A_{2e,(m+1)}$	$\Sigma_m A_{2e,m}$
⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮
	a	$A_{na,1}$	$A_{na,2}$	$A_{na,3}$	....	$A_{na,m}$	$A_{na,(m+1)}$	$\Sigma_m A_{na,m}$
	b	$A_{nb,1}$	$A_{nb,2}$	$A_{nb,3}$	....	$A_{nb,m}$	$A_{nb,(m+1)}$	$\Sigma_m A_{nb,m}$
n	c	$A_{nc,1}$	$A_{nc,2}$	$A_{nc,3}$	....	$A_{nc,m}$	$A_{nc,(m+1)}$	$\Sigma_m A_{nc,m}$
	d	$A_{nd,1}$	$A_{nd,2}$	$A_{nd,3}$	....	$A_{nd,m}$	$A_{nd,(m+1)}$	$\Sigma_m A_{nd,m}$
	e	$A_{ne,1}$	$A_{ne,2}$	$A_{ne,3}$	....	$A_{ne,m}$	$A_{ne,(m+1)}$	$\Sigma_m A_{ne,m}$
Total regional consumption		$\Sigma_n A_{n1}$	$\Sigma_n A_{n2}$	$\Sigma_n A_{n3}$	....	$\Sigma_n A_{nm}$	$\Sigma_n A_{n(m+1)}$	$\Sigma_n \Sigma_m A_{nm}$

Conventional computing procedures can still be used in solving this minimization problem. The solution to the problem will yield the optimum cost pattern of production and shipment for any given price level desired. As the problem is worked, each successively low cost "step" will enter the solution until all consumption requirements for the consuming regions have been met. Then the remaining high cost segments will "supply" a dummy consuming region included in the problem for the purpose of equating total production and consumption.

The number of segments or steps into which the supply function is divided will be determined by adequacy of the data and by the size of computing facilities. The greater the number of segments, the more refined will be the results and the more nearly the "stepped" function will approximate a continuous function; but the bigger will be the computer problem.

The transportation model described above yields solutions readily and appears to be well adapted for use in determining and demonstrating the impact of structural changes that might be expected to occur in the future.[4]

Model II

This model is somewhat more general in nature and is intended to carry the problem one step further than Model I. The first model was used to determine optimum patterns of production and trade for given levels of consumption. Demand prices were brought into the first model only to the extent that price was used in estimating (through the demand function) the levels of consumption to be used. The problem then was one of minimizing cost for supplying the given amounts of consumption. Model I does not determine the equilibrium prices that would equate total production with total consumption.

Model II estimates the level of price or consumption expected to prevail under conditions of equilibrium given the regional supply and demand functions developed in this study. The problem of locating this point is shown for the two-region case in Figure 3 and corresponds to Samuelson's (63) and later King and Henry's (47) concept of maximization of "net social pay-off." Equilibrium would occur at point *A* where the quantity that Consuming Region 2 is willing to take at *OB* price is exactly equal to the quantity that Producing Region 1 is offering at the same price (including transfer costs). "Social pay-off" is the shaded area in the figure. King and Henry have this to say with regard to the concept of "social pay-off."

> "Note that movement of one unit of the commodity from any step of a supply-for-export function to any step of a demand-for-import function results in a social transfer gain equal to the price the importing region will pay at the corresponding demand step, less the sum of the transportation costs per unit, and the price that the exporting region is willing to accept at the corresponding supply step. Total social pay-off is the summation of units transferred times social transfer gain per unit."

Model II maximizes this summation. In doing so it locates the point of equilibrium toward which the industry would be expected to be moving provided conditions of perfect competition prevailed.

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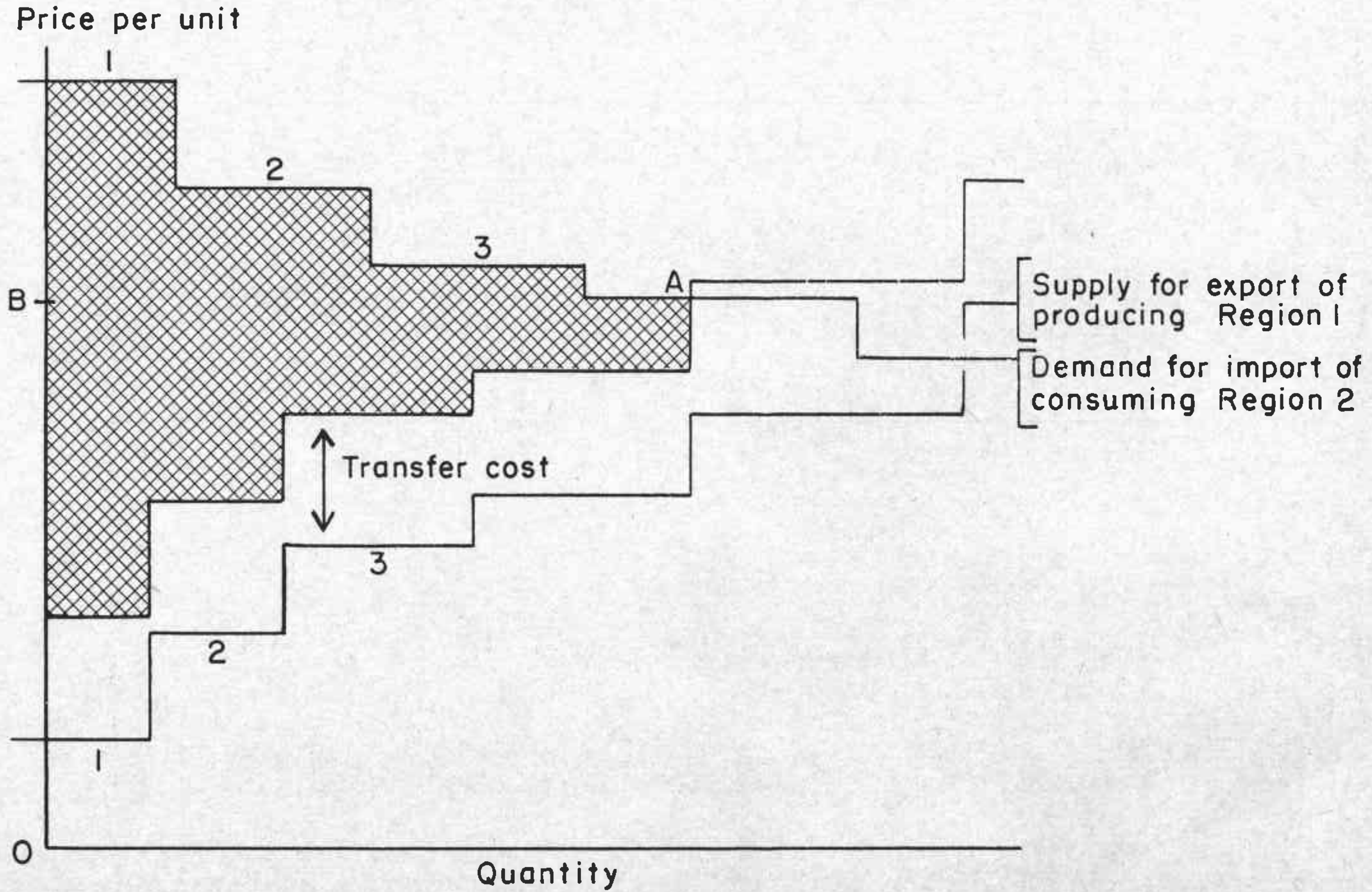
[4] Structural changes as used here include changes in exogeneous factors causing shifts in regional supply and demand relationships such as population, tastes and preferences, incomes, technology, institutions, prices of factors and of alternative or substitute products.

Figure 3. Determination of equilibrium and total social pay-off in the two-region case.



It is unlikely that conditions of perfect competition exist in reality for many industries, and therefore the location of this point may have little relevance to the frozen pea industry. This is especially true for an industry having an inelastic demand for its product and whose revenue position could be improved by reducing production. The model is interesting from a methodological standpoint, and although not fully explored here, does provide a basis for further work towards the inclusion of market imperfections in this type of analysis.

In Model II both the demand and supply functions are stepped whereas in Model I only the supply function is stepped. This results in an even larger matrix than the one shown in Table 3, where there are *n* producing regions each being broken into a, b, c, - - - k "steps" and *m* consuming regions each also broken into a number of "steps."

The supply price (including transportation cost) for each segment of each producing region is subtracted from the demand price for each segment of each consuming region. The computed social transfer gains are entered in the appropriate cells of the expanded matrix. Total production and consumption are again equalized through the use of a dummy consuming region and the solution reached by maximizing "total social pay-off" using transportation problem procedures.

Selection of Producing and Consuming Regions

It generally has been the practice in empirical studies of spatial equilibrium problems to divide the country into a number of regions, both producing and consuming a given product. The selection of regions has been rather arbitrary, but to some extent dictated by the availability of production and consumption data. These regions have been defined in terms of being surplus or deficit regions. Surplus regions export all production over and above internal consumption requirements. Deficit areas import from surplus regions to satisfy their consumption requirements.

Six areas in the United States produce more than 95% of the total frozen pea supply. Production and processing within each area are concentrated to the extent that more homogeneity exists relative to physical and economic factors within the area than among areas. The six pea-producing areas selected as being separate and distinct from the consuming areas are: (1) Blue Mountain area of northeastern Oregon, southeastern Washington, and northwestern Idaho; (2) western Washington; (3) southern Minnesota; (4) western

New York; (5) northern Maine; and (6) southern New Jersey, southern Pennsylvania, Delaware, Maryland, and the eastern seashore of Virginia. These areas will be referred to in the remainder of this study as (1) Eastern Oregon, (2) Western Washington, (3) Minnesota, (4) New York, (5) Maine, and (6) Eastern Seashore (Figure 4). In each of these regions a single point has been selected as the origin of the region's entire supply.

Figure 4. Major producing regions and the city representing each source of supply, United States.

Production Regions

Region no.	States	City designated as center of production area
1	Eastern Oregon, southeastern Washington, and northwestern Idaho	Walla Walla, Washington
2	Western Washington	Seattle, Washington
3	Southern Minnesota	Mankato, Minnesota
4	Western New York	Rochester, New York
5	Northern Maine	Bangor, Maine
6	Southern New Jersey, Delaware, Maryland, and the eastern seashore of Virginia	Wilmington, Delaware

The more important of the minor areas of production in the West which have not been considered are located in California and Utah. Pea-freezing operations in the South are relatively small and in some recent years no peas have been frozen. With the exception of Minnesota, pea freezing in the Midwest is of minor significance. Although Wisconsin is the largest producer of peas for processing, almost all its peas are canned.

Consuming areas have been selected on the basis of availability of data concerning consumption, population, income, and price. Within each consuming region, a city centrally located with respect to the region's population distribution has been selected to receive all imports of frozen peas (Figure 5). This has been done recognizing that many points of destination exist in each consuming region but to consider each would be beyond the scope of this study.

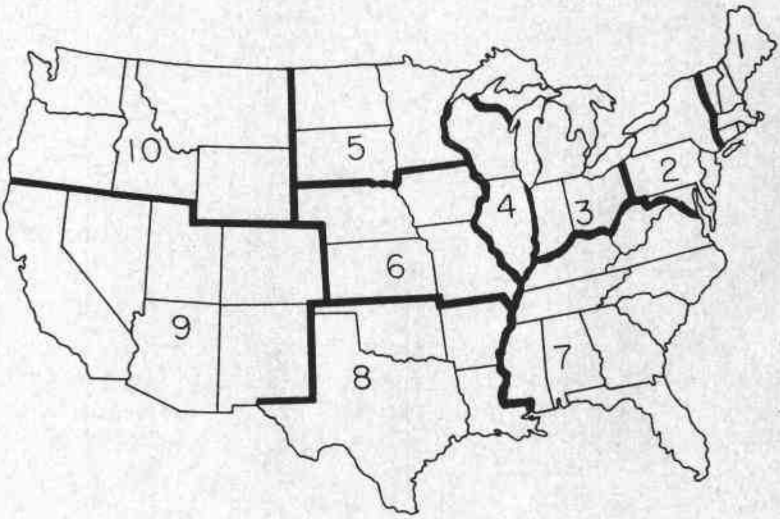
The assumption of a single point representing each producing and consuming region is a necessary simplification which must be made. Several reasons suggest that this limitation does not appear to be of serious consequence to this study. (1) It is the general relationships that are of value in this type of research, and this assumption should not greatly detract from general relationships. (2) With the present marketing structure, frozen foods frequently are shipped from producing areas to centrally located storage facilities and later distributed to retail outlets in the surrounding area. Once the product from a number of areas has been assembled in a storage or distribution center, the identity of the origin of the product is lost and all go through the same subsequent processes. (3) Costs of transportation are the only costs affected by number of consuming regions and when shipping over very great distances even these sometimes are affected very little. For example, when considering transportation costs from Walla Walla, Washington, to the east coast, there is little if any difference in rates to Scranton, Pennsylvania, or New York City. Also rates from Seattle and Walla Walla to the same point in the East or the South are often identical.

It would be of interest to know the effect upon the production pattern obtained by varying the size and number of consuming regions. More regions would permit more graduations in consumption and so would have some effect on distribution patterns.

Demand Relationships

Empirical demand studies of the past 30 to 40 years have utilized two broad approaches; statistical analyses of time series data and

Figure 5. Consuming regions and the city representing each market, United States.



Consumption Regions

Region no.	States	City designated as population center
1	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	Boston, Mass.
2	New York, Pennsylvania, New Jersey, Maryland, Delaware, District of Columbia	Scranton, Pa.
3	Ohio, Indiana, Michigan	Detroit, Mich.
4	Wisconsin, Illinois	Chicago, Ill.
5	Minnesota, North Dakota, South Dakota	Minneapolis, Minn.
6	Iowa, Nebraska, Kansas, Missouri	Omaha, Nebr.
7	Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Georgia, Alabama, Mississippi, Florida	Montgomery, Ala.
8	Arkansas, Louisiana, Texas, Oklahoma	Dallas, Texas
9	California, Nevada, New Mexico, Arizona, Colorado, Utah	Los Angeles, Cal.
10	Oregon, Washington, Idaho, Montana, Wyoming	Portland, Oregon

controlled price-quantity studies within a single time period. This study utilizes the time series approach, and only the problems inherent in this method will be discussed below.

The statistical approach has employed either the least squares single equation model or the system of simultaneous equations.[5] The single equation model is believed to give biased coefficients if the independent variables in time period "*t*" are in any way affected by the dependent variable in time period "*t*." If price is used as the dependent variable, and production (or consumption) and income are the independent variables, biased coefficients are believed to occur if current production or income is measurably affected by price. The simultaneous equations model has been developed to eliminate this bias. Empirical studies utilizing the two models have failed to provide conclusive evidence that one is superior to the other.[6]

Either method of deriving statistical demand curves fails to yield a demand curve fulfilling the assumptions of a demand curve in theory. Demand relationships that exist in any given period in time are not likely to be the same for other time periods. In a dynamic economy all variables affecting demand curves change continuously. In time series analyses the price for any given year merely locates a point on the demand curve existing at that time, but says nothing about the slope of the remainder of the curve. Each recorded point in a study of time series data locates a point on a demand curve and also a point on a supply curve. A point for any given year may differ from the previous year because of (a) movements along the demand curve, (b) shifts in the demand curve, (c) movements along the supply curve, (d) shifts in the supply curve, and (e) any combination of the above. It is evident that the statistical demand curve will coincide with the position or slope of the actual demand curve at any time only by chance and that many problems are involved in the estimation of a meaningful demand or supply function from a series of price-quantity points.[7]

Other considerations appear to be just as important as the problem of method in their effect on the results. Criteria other than

[5] The works of Ezekiel (19) and Shultz (65) were important in the development of the least squares single equation estimate while the simultaneous equations technique has been developed more recently by the Cowles Commission (36).

[6] See discussions by Kuznets (52) and Judge (44) concerning the relative validity of the two models.

[7] Working (85) provides a more complete discussion of the "identification problem."

a priori knowledge and trial and error appear to be lacking in selection of variables, aggregation of data, and adjustments in data.[8]

As pointed out by Foote and Fox (20):

> "It remains to be seen whether a useful compromise can be effected between the complexities of a full description of reality and the need for a model sufficiently aggregated so that it can be manipulated and interpreted without undue expense."

Empirical Demand Relationships

Demand relationships could feasibly be estimated at any level within the marketing channel since a hypothetical schedule exists at each level for the aggregate of factors and services involved up to that point. Demand relationships for this study have been estimated at the retail level.

Efforts to estimate an individual demand function for each region proved fruitless because of the lack of adequate regional data. As a consequence, the following general procedure was followed: An estimate was made of a demand function for the country as a whole, and adjustments were made in the over-all demand function in order to approximate regional demand schedules.

United States demand

In estimating the demand function for frozen peas for the country as a whole, several attempts were made using different models and several sets of variables in different forms. The model selected as being most consistent with *a priori* knowledge was a least squares single equation of the following form:

$$Q = -.390610 - .079385P + .002256DI$$
$$(1.061463) \quad (.026883) \quad (.000498)$$

where Q is the estimated average United States per capita disappearance in pounds of frozen peas, P, the average United States retail price in cents per 10-ounce package, and DI, the average United States per capita disposable income.[9] An independent variable for prices of closely competing substitute commodities was originally included, but the coefficient for the variable was not significant. Data used in deriving the equation for the present analysis are shown in Table 4.

[8] See Hutchings (37) for further discussion relating to these problems.

[9] The coefficient for price was significant at the 5% level, and the coefficient for disposable income at the 1% level. The negative constant term was not significant. Standard errors are shown in parentheses below each coefficient. $R^2 = .914$.

A price-quantity demand schedule at the retail level for the country as a whole, given the level of per capita disposable income, was calculated from the above equation. By holding disposable income constant at the 1959-60 level and inserting a range of retail prices into the equation, it was possible to estimate per capita disappearance at these various levels of price (Table 5).

Developing regional demand schedules

Demand schedules for each of the consuming regions included in this study were developed from the national demand schedule (Table 5) as follows:[10]

1. Regional adjustments in per capita disappearance for the country as a whole were made. They were based on estimates of per capita consumption of frozen peas by region in a single year (1955).[11] National per capita disappearance estimates at the various levels of the prices (column 1 of Table 5) were adjusted using a regional index of consumption (Table 6).

2. Regional adjustments in prices for the country as a whole (column 2 of Table 5) were made. They were based upon a regional index of prices. This index (Table 7), with United States average price equal to 100, was calculated from average retail prices for frozen peas for the 10 crop years, 1950-51 to 1959-60 as reported in 20 cities located in the 10 consuming regions (82).

3. Per capita consumption estimates were converted to regional consumption at various levels of price.

As previously mentioned, the regional index of per capita consumption was based on regional consumption data for a single year.

[10] It is recognized that there are alternative methods of approximating regional demand relationships from a national demand function. For example, see Judge (43, p. 10).

[11] Regional consumption data for 1955 were obtained from a recent study published by the United States Department of Agriculture (61). Four of the 6 regions included in the USDA study were subdivided to form the 10 consuming regions used in this study. It will be noted that the United States average consumption per person as estimated by the USDA study is smaller than that reported in Table 4 for 1955-56. There are two reasons for this apparent discrepancy: (1) Estimates in Table 4 are shown by crop year and those in Table 6 are by calendar year, and (2) data reported by the USDA study account only for retail sales and not for peas used in restaurants or in prepared foods such as soups and frozen dinners. It is assumed that this difference in consumption estimates is spread equally among all regions and that it will not affect the regional pattern of consumption.

Table 4. Per capita disappearance of frozen peas, average retail price of frozen peas, and per capita disposable income, United States, 1950-60

Crop year[1]	Per capita disappearance frozen peas[2]	Retail price per 10-ounce package (1947-49 dollars)[3]	Per capita disposable income (1947-49 dollars)[4]
	Pounds	*Cents*	*Dollars*
1950-51	.947	20.2	1,332
1951-52	1.142	18.3	1,328
1952-53	1.303	17.2	1,339
1953-54	1.438	16.8	1,383
1954-55	1.399	16.9	1,378
1955-56	1.364	18.3	1,450
1956-57	1.738	17.6	1,499
1957-58	1.745	16.3	1,497
1958-59	1.641	16.0	1,472
1959-60	1.681	16.0	1,518

[1] Frozen pea crop year beginning June 1 and ending May 31.
[2] See Appendix Tables 31 and 32 for source and method of calculation.
[3] Average U. S. retail prices are reported by month (82). Prices for crop-year are averages of monthly prices.
[4] Data obtained from *Economic Indicators* (73, p. 4).

Table 5. Estimated consumer's demand schedule for frozen peas, for crop year 1959-60, United States

Estimated per capita disappearance Q[1]	Retail price per 10-ounce package (1947-49 dollars) P	1959-60 per capita disposable income (1947-49 dollars) D_1
Pounds	*Cents*	*Dollars*
1.446	20	1,518
1.526	19	1,518
1.605	18	1,518
1.684	17	1,518
1.764	16	1,518
1.843	15	1,518
1.923	14	1,518
2.002	13	1,518
2.081	12	1,518
2.161	11	1,518
2.240	10	1,518

[1] Estimated from the demand equation:
$Q = -.390610 - .079385\ P + .002256\ D_1$ by varying price, holding disposable income constant, and solving for per capita disappearance.

Table 6. Average annual purchases of frozen peas per family member by region and for the United States, 1955

Region[1]	Consumption per household member[2]	Index
	Pounds	
Northeast	1.78	157
East North Central	0.89	79
West North Central	0.83	73
Southeast	0.58	51
West South Central	0.36	32
West	2.00	177
United States average	1.13	100

[1] Regions for USDA consumption data comprise the following states:
Northeast: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Maryland, Delaware, District of Columbia.
East North Central: Ohio, Indiana, Michigan, Illinois, Wisconsin.
West North Central: Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Iowa, Missouri.
Southeast: Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi.
West South Central: Arkansas, Louisiana, Oklahoma, Texas.
West: California, Oregon, Washington, Idaho, Montana, Wyoming, Utah, Colorado, Nevada, Arizona, New Mexico.

[2] Data obtained from a survey conducted under contract by the Market Research Corporation of America (61, p. 83).

The implicit assumption is made that the current regional pattern of consumption is the same as the pattern that existed in 1955. Adjusted per capita consumption figures for the 10 consuming regions of this study are shown in Table 8 for the range of average United States prices indicated.

In previous studies of this kind, conditions of perfect competition with respect to price have been assumed. This means that the difference in retail prices among regions is directly related to transportation cost to each region from a common base point. This procedure has not been used here because the series of retail prices mentioned above does not conform to such a pattern of regional prices. The difference between the theoretical pattern of prices and that shown in Table 7 is believed due largely to imperfections in the market. It is recognized that the sample of reported prices is small and somewhat inadequate for determining existing prices, but nevertheless is more realistic than a pattern developed by adjusting prices to a common base point or region. Prices adjusted by the index in Table 7 for each of the 10 consuming regions are shown in Table 9.

Table 7. Index of average retail prices of frozen peas by region for crop years 1950-51 through 1959-60

Consuming region	Average retail price of frozen peas[1] (Per 10-ounce package)	Index
	Cents	
1	19.12	96.0
2	19.95	100.2
3	20.44	102.7
4	19.07	95.8
5	19.88	99.8
6	19.84	99.6
7	20.49	102.9
8	19.78	99.3
9	20.20	101.5
10	19.73	99.1
United States	19.91	100.0

[1] Average of prices in each region for crop years 1950-51 through 1959-60. Prices obtained from cities in each region as follows (82):

Consuming region	Cities for which prices are reported
1	Boston
2	New York, Pittsburgh, Scranton
3	Detroit, Cleveland, Cincinnati
4	Chicago
5	Minneapolis
6	Kansas City, St. Louis
7	Atlanta
8	Houston
9	San Francisco, Los Angeles
10	Seattle, Portland

The final step in the development of regional demand schedules was accomplished by multiplying per capita consumption at each price level by the estimated population of each region in 1959. (See Appendix Table 38 for population estimates.) Two minor adjustments consisted of converting 1947-49 dollars in the demand function to 1959 prices, and the estimated regional consumption from pounds to 10-ounce packages. Regional demand schedules of consumption and price are shown in Table 10.

Price elasticities of demand

The linear demand function for the United States as estimated here has different degrees of elasticity at its various points or prices. It is elastic in the upper range of prices and inelastic in the area of lower prices. The average price elasticity for the range of prices

Table 8. Estimated per capita disappearance of frozen peas by region at various levels of United States average retail price, 1959

U. S. average retail price	U. S. average per capita consumption[1]	Consuming regions									
		1	2	3	4	5	6	7	8	9	10
Cents	*Pounds*	*Per capita disappearance in pounds*									
20	1.446	2.27022	2.27022	1.14234	1.14234	1.05558	1.05558	.73746	.46272	2.55942	2.55942
19	1.526	2.39582	2.39582	1.20554	1.20554	1.11398	1.11398	.77826	.48832	2.70102	2.70102
18	1.605	2.51985	2.51985	1.26795	1.26795	1.17165	1.17165	.81855	.51360	2.84085	2.84085
17	1.684	2.64388	2.64388	1.33036	1.33036	1.22932	1.22932	.85884	.53888	2.98068	2.98068
16	1.764	2.76948	2.76948	1.39356	1.39356	1.28772	1.28772	.89964	.56448	3.12228	3.12228
15	1.843	2.89351	2.89351	1.45597	1.45597	1.34539	1.34539	.93993	.58976	3.26211	3.26211
14	1.923	3.01911	3.01911	1.51917	1.51917	1.40379	1.40379	.98073	.61536	3.40371	3.40371
13	2.002	3.14314	3.14314	1.58158	1.58158	1.46146	1.46146	1.02102	.64064	3.54354	3.54354
12	2.081	3.26717	3.26717	1.64399	1.64399	1.51913	1.51913	1.06131	.66592	3.68337	3.68337
11	2.161	3.39277	3.39277	1.70719	1.70719	1.57753	1.57753	1.10211	.69152	3.82497	3.82497
10	2.240	3.51680	3.51680	1.76960	1.76960	1.63520	1.63520	1.14240	.71680	3.96480	3.96480
	Index[2]	157	157	79	79	73	73	51	32	177	177

[1] As estimated from demand equation. See Table 5.
[2] Adjusted by index of consumption per household member in 1955. See Table 6.

Table 9. Estimated retail prices of frozen peas by region at various levels of United States per capita disappearance, 1959

U. S. average per capita disappearance[1]	U. S. average retail price per 10-ounce package	Consuming regions									
		1	2	3	4	5	6	7	8	9	10
Pounds	*Cents*	*Cents per 10-ounce package*									
1.446	20	19.2	20.0	20.5	19.2	20.0	19.9	20.6	19.9	20.3	19.8
1.526	19	18.2	19.0	19.5	18.2	19.0	18.9	19.6	18.9	19.3	18.8
1.605	18	17.3	18.0	18.5	17.2	18.0	17.9	18.5	17.9	18.3	17.8
1.684	17	16.3	17.0	17.5	16.3	17.0	16.9	17.5	16.9	17.3	16.8
1.764	16	15.4	16.0	16.4	15.3	16.0	15.9	16.5	15.9	16.2	15.9
1.843	15	14.4	15.0	15.4	14.4	15.0	14.9	15.4	14.9	15.2	14.9
1.923	14	13.4	14.0	14.4	13.4	14.0	13.9	14.4	13.9	14.2	13.9
2.002	13	12.5	13.0	13.4	12.5	13.0	12.9	13.4	12.9	13.2	12.9
2.081	12	11.5	12.0	12.3	11.5	12.0	12.0	12.3	11.9	12.2	11.9
2.161	11	10.6	11.0	11.3	10.5	11.0	11.0	11.3	10.9	11.2	10.9
2.240	10	9.6	10.0	10.3	9.6	10.0	10.0	10.3	9.9	10.2	9.9
	Index[2]	96.0	100.2	102.7	95.8	99.8	99.6	102.9	99.3	101.5	99.1

[1] See Table 5.
[2] Index of average prices. See Table 7.

Table 10. Approximated regional demand schedules for frozen peas[1]

Consuming regions																			
1		2		3		4		5		6		7		8		9		10	
Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
Cents	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*	*Cents*	*Thous. pkgs.*
23.9	36,883	24.9	138,295	25.5	40,755	23.9	25,981	24.9	7,985	24.8	17,984	25.7	39,536	24.8	12,363	25.3	80,235	24.7	25,631
22.7	38,923	23.7	145,946	24.3	43,010	22.7	27,419	23.7	8,427	23.5	18,979	24.4	41,723	23.5	13,047	24.0	84,674	23.4	27,049
21.6	40,938	22.4	153,501	23.1	45,236	21.4	28,838	22.4	8,863	22.3	19,961	23.1	43,883	22.3	13,723	22.8	89,057	22.2	28,449
20.3	42,954	21.2	161,057	21.8	47,463	20.3	30,258	21.2	9,300	21.1	20,944	21.8	46,043	21.1	14,398	21.6	93,441	20.9	29,850
19.2	44,994	19.9	168,708	20.4	49,718	19.1	31,695	19.9	9,741	19.8	21,939	20.6	48,231	19.8	15,082	20.2	97,880	19.8	31,268
17.9	47,009	18.7	176,263	19.2	51,944	17.9	33,115	18.7	10,178	18.6	22,921	19.2	50,391	18.6	15,757	18.9	102,263	18.6	32,668
16.7	49,050	17.4	183,915	17.9	54,199	16.7	34,552	17.4	10,619	17.3	23,916	17.9	52,578	17.3	16,441	17.7	106,702	17.3	34,086
15.6	51,065	16.2	191,470	16.7	56,426	15.6	35,971	16.2	11,056	16.1	24,899	16.7	54,738	16.1	17,117	16.4	111,086	16.1	35,486
14.3	53,080	15.0	199,026	15.3	58,652	14.3	37,391	15.0	11,492	15.0	25,881	15.3	56,898	14.8	17,792	15.2	115,469	14.8	36,887
13.2	55,120	13.7	206,677	14.1	60,907	13.1	38,828	13.7	11,934	13.7	26,876	14.1	59,085	13.6	18,476	14.0	119,908	13.6	38,305
12.0	57,135	12.5	214,232	12.8	63,134	12.0	40,248	12.5	12,370	12.8	27,859	12.8	61,245	12.3	19,152	12.7	124,292	12.3	39,705

[1] All prices are expressed in terms of the 1959 price level.

shown in Table 5 is –.6760. Average income elasticity for the range of per capita disposable incomes of $1,580 to $2,203 (1959 dollars) was 1.9754.

Although the demand schedule for each of the 10 consuming regions was based upon the relationships obtained in the demand equation for the United States, price elasticities differ slightly for the various regions. This can be explained by differences in magnitudes of prices and quantities involved in each region. Average price elasticities for the regional demand curves ranged from –.6674 to –.6901.

Supply Relationships

This section is concerned with the development of long-run regional supply relationships to be used to predict the quantity of green peas that would be supplied in response to different prices. Supply response as a theoretical consideration has been given frequent attention in the literature. Empirical investigations of interregional competition, however, largely have avoided this important issue by assuming that the quantity to be supplied is given for a particular period or that supply is infinitely elastic.

Problems and Procedures

One approach to the estimation of supply response begins with the determination of supply curves for individual firms comprising the industry. This can be done by several different methods: (1) By estimating each firm's production function and related cost curves (under perfect competition the marginal cost curve is the firm's supply curve), (2) by budgeting or synthesizing optimum patterns of production under various price-cost relationships, and (3) by obtaining from a sample of firms estimates of their supply response to price change.

Each of the three methods described above requires the aggregation of all firm supply functions into a single regional supply curve. This is relatively simple once the supply function for each existing and potential firm in the region is known. Research procedures can cope with this problem in the short run where the number and size are fixed, but procedures have not been developed to determine long-run relationships for either existing or potential firms.

Determination of long-run supply relationships by analysis of time series data appears to be a more "practical" approach. This method, however, involves all of the problems encountered in the estimation of demand as discussed in the previous section. These include the selection of statistical techniques, the selection of variables, the form of variables or adjustments necessary in the data, and the level of aggregation.

Another problem pertinent to developing long-run supply estimates is concerned with the "length of run" or length of the supply period. In economic theory, different writers define length of the supply period in different ways. One definition includes three lengths of run: (1) Market period—one short enough to have a fixed supply of the product; (2) short-run period—one long enough to permit adjustments in volume of product by increasing or decreasing variable inputs, but not fixed resources; and (3) long-run period—one long enough to allow adjustments in volume of output by changes in both variable and fixed resources. The latter is long enough to permit new firms to enter and existing firms to drop out of the industry.

In this study a long-run supply period is assumed, but at the same time certain conditions are assumed to be constant so that changes in supply move along the curve rather than being represented by shifts in the supply curve. The four conditions held constant are: Absolute prices of factors of production and competing commodities, the state of technology, preferences of producers for production alternatives, and institutions.

Estimating Supply Response

The following approaches were used in attempting to develop estimates of supply response:

1. Estimates of pea growers.

2. Estimates of pea processors.

3. Use of time series data.

Approach number three provided the most realistic estimates and is the one used in this analysis.[12] In developing the analysis based on this method, several different models, utilizing several sets of variables, were considered.

[12] In method number one producers in each region were asked to estimate their production response to changes in grower prices for peas. In most cases growers either could not or would not answer the question.

The second attempt involved sending a questionnaire to the management of all pea-freezing firms. It asked them to estimate their grower's production response to changes in grower prices. Their answers indicated their estimate of the prices they would be required to pay for production increases and decreases of 10, 25, and 50%. These estimates were of interest, but they could not be used for two reasons. First, a change of 50% in pea production in areas

United States supply

The model decided upon took the following form:

$$Q_{(t)} = -16{,}263. + 3{,}320.105\, GP_{(t-1)} - 2{,}765.69\, CS_{(t-1)}$$
$$(111{,}991.)\quad (1{,}261.914) \qquad\qquad (944.33)$$

where $Q_{(t)}$ is the estimated United States production of peas for freezing in tons by crop year, $GP_{(t-1)}$ is the United States average grower price per ton in period t-1 times the United States five-year-moving-average yield per acre in tons, and $CS_{(t-1)}$ is the cold storage holdings of frozen green peas on December 31 of crop year t-1 as a percent of production in t-1.[13] This function was derived from data shown in Table 11.

Independent variables used in this regression seem plausible. When the grower and the processor get together to decide on the quantity of peas to be contracted and produced in the succeeding year, certainly prices received by growers in the preceding year and holdover from the preceding year are important factors. Prices received by growers per acre (reflecting the upward tendency of yield in recent years) are an important factor to the grower in weighing the production of peas for freezing against other alternatives. Cold storage holdings or carry-over from last season is also an important factor, particularly from the standpoint of the processor in deciding how many acres he should contract in the ensuing year. Because contracts are negotiated early in the year, December 31 holdings were used as the latest available information at time of negotiation.

A price-quantity supply schedule at the grower level for the country as a whole, given current cold storage holdings, was calculated from the above equation. By assuming cold storage holdings constant in the equation at the level of the average for the last four years and inserting different grower prices into the equation, an estimate was made of the quantity that would be produced at various levels of prices (Table 12).

---

producing a small quantity of peas would involve only a small absolute change. Secondly, the task of aggregating processor estimates proved to be insurmountable. This would have required an appraisal of not only existing firms but potential firms that might enter the industry. Estimating the number, size, location, boundaries of raw product procurement areas for potential firms, and their effect on the supply response of existing firms would be difficult if not impossible.

[13] The coefficients for $GP_{(t-1)}$ and $CS_{(t-1)}$ were significant at the 5% level. The negative constant term was not significant. Standard errors for each coefficient are shown below it in parenthesis. $R^2 = .560$.

Table 11. Production of peas for freezing, average grower prices received per acre, and cold storage holdings of frozen peas, United States, 1948-60

Crop year[1]	U. S. production of peas for freezing[2]	U. S. average grower price received per acre[3]	December 31 cold storage holdings of frozen peas as percent of production[4]
	Tons	$	%
1947-48	....	93.82	77.5
1948-49	72,420	91.71	64.2
1949-50	74,240	89.71	61.2
1950-51	97,450	83.13	54.0
1951-52	120,620	83.45	54.0
1952-53	118,190	91.28	59.7
1953-54	129,200	97.41	60.4
1954-55	117,280	94.31	52.3
1955-56	133,740	94.36	46.6
1956-57	199,490	104.19	54.9
1957-58	158,830	105.58	73.9
1958-59	137,510	105.17	70.0
1959-60	170,320	115.28	60.4

[1] Frozen pea crop year beginning June 1 and ending May 31.
[2] Reported by the United States Department of Agriculture (80).
[3] U. S. average grower price per ton times the U. S. 5-year-moving-average yield per acre in tons. See Appendix Tables 34 and 35 for source and method of calculation.
[4] See Appendix Table 36 for source and method of calculation.

Regional price and production adjustments

The United States supply schedule described above was used as a basis for estimating regional production as a function of regional prices. The necessary adjustments to accomplish this consisted of the following steps:

1. An index of regional costs of production (Table 13) was computed. (See Appendix A for detailed information on estimated costs of production.) This index was used to develop estimates of regional prices paid growers by applying it to the United States average (Table 14).

2. Estimated total United States production at different levels of grower prices was allocated to the different producing regions on the basis of each region's production during the two years 1958-60. Estimated regional production at various levels of average United States grower prices is shown in Table 15.

Table 12. **Estimated supply schedule for producing peas for freezing, United States, crop year, 1959-60**

Estimated production of peas for freezing[1] $Q_{(t)}$	Price per acre received by grower $GP_{(t-1)}$	Cold storage holdings as a percent of production[2] $CS_{(t-1)}$
Tons	$	%
36,927.638	70.00	64.8
53,528.163	75.00	64.8
70,128.688	80.00	64.8
86,729.213	85.00	64.8
103,329.738	90.00	64.8
119,930.263	95.00	64.8
136,530.788	100.00	64.8
153,131.313	105.00	64.8
169,731.838	110.00	64.8
186,332.363	115.00	64.8
202,932,888	120.00	64.8
219,533.413	125.00	64.8
236,133.938	130.00	64.8
252,734.463	135.00	64.8
269,334.988	140.00	64.8
285,935.513	145.00	64.8
302,536.038	150.00	64.8

[1] Estimated from the supply equation:

$Q_{(t)} = -16{,}263. + 3{,}320.105\ GP_{(t-1)} - 2{,}765.69\ CS_{(t-1)}$

by varying grower price, holding cold storage holdings constant, and solving for production of peas for freezing.

[2] Latest four-year average.

Table 13. **Index of costs of production of peas for freezing by major producing areas, 1959**

Producing region	Cost per acre	Index[1]
	$	
Eastern Oregon	82.52	73.28
Maine	101.53	90.17
Western Washington	174.26	154.76
Minnesota	102.68	91.19
New York	106.64	94.71
Eastern Seashore	162.31	144.15

[1] The weighted average cost for the country as a whole was used as the base: $112.60 = 100. This figure was calculated using costs shown above and 1958-59 and 1959-60 crop-year acreage by regions as weights.

Table 14. Estimated regional prices paid to grower for producing peas for freezing in major producing areas at various levels of United States production

Estimated United States production[1]	Average United States prices paid grower[1]	Producing regions					
		Eastern Oregon	Maine	Western Washington	Minnesota	New York	Eastern Seashore
Tons	*Dollars/acre*	*Dollars per acre*					
36,927.638	70.00	51.30	63.12	108.33	63.83	66.30	100.90
53,528.163	75.00	54.96	67.63	116.07	68.39	71.03	108.11
70,128.688	80.00	58.62	72.14	123.81	72.95	75.77	115.32
86,729.213	85.00	62.29	76.64	131.55	77.51	80.50	122.53
103,329.738	90.00	65.93	81.15	139.28	82.07	85.24	129.74
119,930.263	95.00	69.62	85.66	147.02	86.63	89.97	136.94
136,530.788	100.00	73.28	90.17	154.76	91.19	94.71	144.15
153,131.313	105.00	76.94	94.68	162.50	95.75	99.45	151.36
169,731.838	110.00	80.61	99.19	170.24	100.31	104.18	158.56
186,332.363	115.00	84.27	103.70	177.97	104.87	108.92	165.77
202,932.888	120.00	87.94	108.20	185.71	109.43	113.65	172.98
219,533.413	125.00	91.60	112.71	193.45	113.99	118.39	180.19
236,133.938	130.00	95.26	117.22	201.19	118.55	123.12	187.40
252,734.463	135.00	98.93	121.73	208.93	123.11	127.86	194.60
269,334.988	140.00	102.59	126.24	216.66	127.67	132.59	201.81
285,935.513	145.00	106.26	130.75	224.40	132.23	137.33	209.02
302,536.038	150.00	109.92	135.26	232.14	136.78	142.06	216.22
	Index[2]	73.28	90.17	154.76	91.19	94.71	144.15

[1] *Source:* Table 12.
[2] *Source:* Table 13.

Table 15. **Estimated regional production of peas for freezing at various levels of United States average prices paid to growers**

Price per acre received by growers[1]	Estimated United States production of peas for freezing[1]	Producing regions					
		Eastern Oregon	Maine	Western Washington	Minnesota	New York	Eastern Seashore
Dollars	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
70.00	36,927.638	15,369.283	1,960.858	12,038.410	3,892.173	827.197	2,839.735
75.00	53,528.163	22,278.421	2,842.345	17,450.181	5,641.868	1,199.031	4,116.316
80.00	70,128.688	29,187.560	3,723.833	22,861.952	7,391.564	1,570.883	5,392.896
85.00	86,729.213	36,096.698	4,605.321	28,273.723	9,141.259	1,942.734	6,669.476
90.00	103,329.738	43,005.837	5,486.809	33,685.495	10,890.954	2,314.586	7,946.057
95.00	119,930.263	49,914.975	6,368.297	39,097.266	12,640.650	2,686.438	9,222.637
100.00	136,530.788	56,824.114	7,249.785	44,509.037	14,390.345	3,058.290	10,499.218
105.00	153,131.313	63,733.252	8,131.273	49,920.808	16,140.040	3,430.141	11,775.798
110.00	169,731.838	70,642.391	9,012.761	55,332.579	17,889.736	3,801.993	13,052.378
115.00	186,332.363	77,551.529	9,894.248	60,744.350	19,639.431	4,173.845	14,328.959
120.00	203,932.888	84,460.668	10,775.736	66,156.121	21,389.126	4,545.697	15,605.539
125.00	219,533.413	91,369.806	11,657.224	71,567.893	23,138.822	4,917.548	16,882.119
130.00	236,133.938	98,278.945	12,538.712	76,979.664	24,888.517	5,289.400	18,158.700
135.00	252,734.463	105,188.084	13,420.200	82,391.435	26,638.212	5,661.252	19,435.280
140.00	269,334.988	112,097.222	14,301.688	87,803.206	28,387.908	6,033.104	20,711.861
145.00	285,935.513	119,006.361	15,183.176	93,214.977	30,137.603	6,404.955	21,988.441
150.00	302,536.038	125,915.499	16,064.664	98,626.748	31,887.298	6,776.807	23,265.021
	Index[2]	41.62	5.31	32.60	10.54	2.24	7.69

[1] *Source:* Table 12.
[2] Indicates percentage of total U. S. production in crop years 1958-59 and 1959-60 for each region.

Regional supply schedules

The above procedure estimates regional supply relationships at the grower level. It is necessary to add the supply schedules for processing, transportation, and distribution services to the regional farm schedules. The procedures used in accomplishing this are shown below.

Frozen peas make up only a relatively small percentage of the total amount of food being transported and distributed among regions. Consequently, it is unlikely that any changes in the amount of frozen peas being shipped from any given origin to any given destination or being distributed within any consuming region will affect prices of transportation or distribution services. Therefore, the assumption of a perfectly elastic supply function (a constant supply price) for these services has been made.

A similar simplifying assumption has been made relative to processing services. The resources or factors devoted to the processing and freezing of peas in any production area are only a small proportion of total resources. Considerable expansion or contraction in the processing of peas for freezing, therefore, could take place without significantly affecting costs or prices of these factors. For example, any expansion of processing in any producing area over the range considered in this analysis would be unlikely to affect the level of wage rates in the area.

The first step in raising the supply schedules to the retail level is to add a constant amount to each regional supply schedule which will reflect the estimated processing costs developed for each region (see Appendix B for a discussion of processing costs). The result is a schedule of supply prices at the processor level for each region (Table 16). Both prices and production are expressed in terms of 10-ounce retail packages. Processing costs used were those for plants of 30,000 pounds per hour output in Eastern Oregon and 20,000 pounds per hour in all other areas (see Appendix B). Both production and processing costs were adjusted for a 10% loss of product in processing.

The final adjustment needed to raise the supply schedules to the retail level is the addition of distribution and transportation costs. The latter will vary depending upon the producing region making the shipments and the consuming region receiving the product. They will be taken into account later.

Supply elasticities

Average elasticities for the six producing regions ranged from 6.5 to 10.1. Differences in supply elasticities are due to differences

Table 16. Approximated regional processed product supply schedules

Producing regions											
Eastern Oregon		Maine		Western Washington		Minnesota		New York		Eastern Seashore	
FOB processor supply price per 10-oz. pkg.	Estimated production	FOB processor supply price per 10-oz. pkg.	Estimated production	FOB processor supply price per 10-oz. pkg.	Estimated production	FOB processor supply price per 10-oz. pkg.	Estimated production	FOB processor supply price per 10-oz. pkg.	Estimated production	FOB processor supply price per 10-oz. pkg.	Estimated production
Dollars	*Thous. pkgs.*	*Dollars*	*Thous. pkgs.*	*Dollars*	*Thous. pkgs.*	*Dollars*	*Thous. pkgs.*	*Dollars*	*Thous. pkgs.*	*Dollars*	*Thous. pkgs.*
.0828	49,181.706	.0826	6,274.746	.0864	38,522.912	.0884	12,454.954	.0881	2,646.973	.0934	9,087.152
.0840	71,290.947	.0838	9,095.504	.0878	55,840.579	.0898	18,053.978	.0896	3,836.899	.0955	13,172.211
.0851	93,400.192	.0849	11,916.266	.0891	73,158.246	.0912	23,653.005	.0911	5,026.826	.0976	17,257.267
.0863	115,509.434	.0861	14,737.027	.0904	90,475.914	.0927	29,252.029	.0926	6,216.749	.0997	21,342.323
.0874	137,618.678	.0872	17,557.789	.0918	107,793.584	.0941	34,851.053	.0940	7,406.675	.1018	25,427.382
.0886	159,727.920	.0884	20,378.550	.0931	125,111.251	.0956	40,450.080	.0955	8,596.602	.1039	29,512.438
.0898	181,837.165	.0896	23,199.312	.0945	142,428.918	.0971	46,049.104	.0970	9,786.528	.1059	33,597.498
.0909	203,946.406	.0908	26,020.074	.0958	159,746.586	.0985	51,648.128	.0985	10,976.451	.1081	37,682.554
.0921	226,055.651	.0919	28,840.835	.0972	177,064.253	.0999	57,247.155	.1000	12,166.378	.1101	41,767.610
.0932	248,164.893	.0931	31,661.594	.0985	194,381.920	.1014	62,846.179	.1015	13,356.304	.1122	45,852.669
.0944	270,274.138	.0942	34,482.355	.0999	211,699.587	.1028	68,445.203	.1030	14,546.230	.1143	49,937.725
.0956	292,383.379	.0954	37,303.117	.1012	229,017.258	.1042	74,044.230	.1045	15,736.154	.1164	54,022.781
.0967	314,492.624	.0965	40,123.878	.1026	246,334.925	.1057	79,643.254	.1060	16,926.080	.1185	58,107.840
.0979	336,601.869	.0977	42,944.640	.1039	263,652.592	.1071	85,242.278	.1075	18,116.006	.1206	62,192.896
.0990	358,711.110	.0989	45,765.402	.1052	280,970.259	.1086	90,841.306	.1090	19,305.933	.1226	66,277.955
.1002	380,820.355	.1000	48,586.163	.1066	298,287.926	.1100	96,440.330	.1105	20,495.856	.1248	70,363.011
.1013	402,929.597	.1012	51,406.925	.1079	315,605.594	.1114	102,039.354	.1119	21,685.782	.1268	74,448.067

in magnitude of quantities and prices in each region and do not reflect regional production alternatives.

The average elasticities may seem rather high, but they may not be unrealistic for a contract crop whose acreage is largely controlled by the processors. It could be that existing prices may be higher than is necessary to obtain the desired acreage. Another reason for the high elasticities may be due to the "time series" approach. Supply relationships resulting from this approach may reflect shifts downward and to the right in the supply curve as they have occurred over time because of new technologies and operating techniques. This would tend to make the estimated function more elastic than would otherwise be the case.

Transportation and Distribution Cost Estimates

Transportation costs are crucial to this type of analysis because of their importance in determining costs f.o.b. the consuming regions. Costs of distribution, on the other hand, for any given consuming region will tend to increase the f.o.b. consuming center price by a like amount regardless of the origin of the product. Though not as important in terms of the interregional aspects of the study, distribution costs must be considered in order to adjust supply prices upwards to the retail level so they will be comparable with demand prices.

Frozen peas constitute only a small percentage of the total amount of food being transported and distributed among regions. It is, therefore, unlikely that any realistic changes in the amount of frozen peas being shipped from any given origin to any given destination or being distributed within any consuming region will affect the price of these services. Therefore, the assumption of a perfectly elastic supply function (a constant supply price) is made for distribution and transportation services. These have been estimated under the assumption that the current level and structure of distribution and transportation costs are an acceptable approximation of long-run costs for these services.

Transportation Costs

In order to introduce transportation costs into the analysis, a single point in each producing and consuming region was selected and transportation costs estimated between each of these points. This was done with full recognition that many producing and consuming points exist in each region. Present computer facilities, however, do not permit all to be considered.

Table 17. Least cost transportation rates from major producing regions to selected consuming regions, 1959[1]

To—Consuming regions		From—Major pea-freezing regions					
		Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
Region	Destination point	Walla Walla, Washington	Seattle, Washington	Mankato, Minnesota	Rochester, New York	Bangor, Maine	Wilmington, Delaware
		Dollars per hundredweight					
1	Boston, Mass.	2.57	2.57	2.50	1.48	1.43	1.22
2	Scranton, Pa.	2.52	2.52	2.56	1.11	1.95	.95
3	Detroit, Michigan	2.38	2.38	1.90	1.14	2.39	1.67
4	Chicago, Ill.	2.32	2.32	1.52	1.36	2.52	1.89
5	Minneapolis, Minn.	2.16	2.16	.67	2.39	2.55	2.18
6	Omaha, Nebraska	2.15	2.15	1.25	2.61	2.29	1.42
7	Montgomery, Ala.	2.43	2.43	1.67	2.06	2.74	1.87
8	Dallas, Texas	2.32	2.32	1.87	2.55	3.58	2.64
9	Los Angeles, Calif.	1.41	1.41	2.31	2.66	2.69	2.71
10	Portland, Oregon	.62	.62	2.21	2.66	2.69	2.69

[1] The lowest cost means—truck or rail—are quoted. Rates are based on minimum weights as noted in Appendix Tables 27 and 28 and have been converted to net weight basis.

A point near the geographic center of production in each producing region was chosen to represent all points of origin in the region. In a similar manner a point near the center of population in each consuming region was selected to represent all points of distribution in that region.

Most empirical studies of interregional competition have relied upon transportation cost estimates based solely upon distance. Studies of existing rate structures indicate that variables other than distance have important effects on the rate structure. Other important factors include the amount of competition for transporting products over each route and the availability of "back hauls."

Transportation costs used in this analysis have been based on quoted 1959 rates of rail and truck commercial carriers.[14] These rates include the cost of protective services or refrigeration charges (Appendix Tables 27 and 28). The least cost method of shipment has been selected from each shipping point to each consuming area and these rates are shown in Table 17.

Distribution Costs

The cost of distributing frozen peas has been estimated to be 6 cents per 10-ounce package or $9.60 per hundredweight. This estimate represents the cost of wholesaling and retailing frozen peas in each consuming region. It was obtained from an analysis of published materials relating to marketing margins for fruits and vegetables (4, 27, 75, 76, 77, 78).

Results of the Analysis

This section brings together all of the material developed in earlier phases of the study and analyzes it in terms of projected patterns of regional production and consumption of frozen peas under certain assumed conditions. The results have been achieved by use of a cost minimizing model, Model I, and a maximizing model referred to as Model II. Solutions for each have been made through use of the transportation model of linear programming. Calculations were made on the IBM 1620 computer.[15]

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[14] These rates are assumed to reflect "back-hauls," competition, and other factors affecting the rate structure.

[15] The transportation program for the IBM 1620 computer is based on the maximal flow in networks as proposed by Ford and Fulkerson (22). Input data are dimensions of rows (M), columns (N), their product (MN), surpluses (A_i) (or sources), shortages (B_j) (or destinations), and costs (C_{ij}) associated with respective A_i's and B_j's. The sum of A_i must equal the sum of B_j;

In obtaining these results certain assumptions have been made in order to facilitate the analysis and to better interpret the results. These assumptions follow.

1. Frozen peas are of homogeneous quality and of a single grade. Under these conditions, consumers are indifferent as to source of product.

2. All peas are marketed in retail packages. The regional cost pattern for other container sizes is expected to follow closely the relative cost pattern for the 10-ounce consumer-size package.

3. All peas are produced in the six producing regions included in this analysis. Currently, these regions produce more than 95% of the total pea supply.

4. Cold storage carry-over from one year to the next is assumed to remain a constant percentage of each year's production.

5. Foreign imports or exports of frozen peas are insignificant. Members of the industry report that foreign trade in frozen peas has been negligible in the past, although exports have increased during the past two years.

6. The objective of all firms is profit maximization. Therefore, supplies will originate in those regions producing, processing, and selling at the lowest total cost.

7. Demand and supply relationships developed earlier are taken as given unless otherwise specified.

8. Single points within each producing and consuming region have been selected as sources or destinations of all peas produced.

Model I

This model has been designed to determine the regional production and trade pattern which would minimize total costs of production, processing, transportation, and distribution of the total national supply of frozen peas under both current and possible future conditions. Measurements will be made of each region's competitive position as it is affected by changes in population, per capita incomes, technology, transportation costs, and supply and demand elasticities.

A_i, B_j, and C_{ij} must be non-negative and are five (5) positions each. All calculations are performed with fixed point arithmetic. Computing time for each problem was approximately 25 minutes plus input-output time. Approximately 40 minutes were required to print the input data and the solution. Capacity of the computer for problems of this type is based on the following:

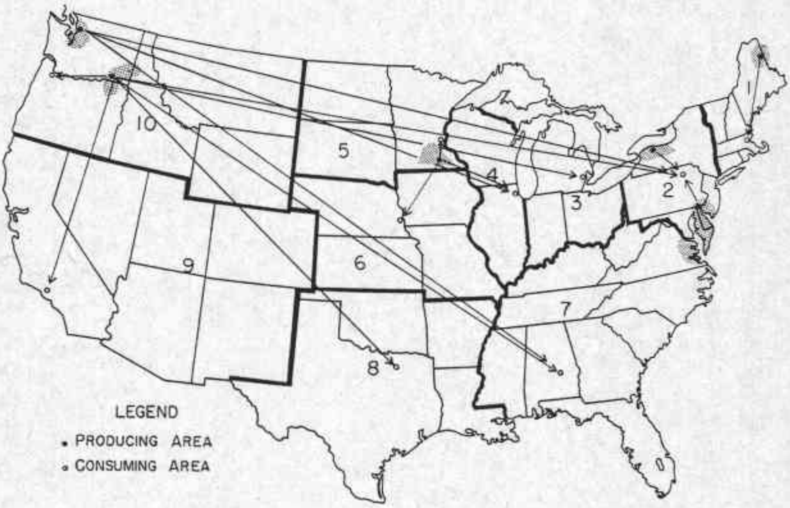
$$10\,MN + 24M + 19N = 14{,}566$$

The size of these problems based on the above formula was 13,877—near the capacity of the computer.

Situations with varying demand conditions

In Situation 1, which assumes 1959 conditions, the analysis shows that the optimum allocation of production would be heavily concentrated in Eastern Oregon and Western Washington (Table 18). These two regions would produce and ship almost 73% of the nation's frozen peas. Minnesota would produce about 10% and the other three regions together about 17%. It is believed that this allocation of production is in close agreement with actual pack statistics.[16]

Figure 6. Shipment pattern for Situations 1 and 2.



The shipment and consumption pattern for Situation 1 shows that in order to minimize costs Eastern Oregon ships to consuming Regions 2, 3, 7, 8, 9, and 10 (Table 18 and Figure 6). Maine's entire supply goes to Region 1 while Western Washington ships to Regions 2, 4, and 7. Consuming Regions 4, 5, and 6 receive shipments from Minnesota while the total production of New York and Eastern Seashore goes to Region 2. Whether this conforms to the actual shipping

[16] It will be noted in Table 18 that the demand equation using the past 3-year average U. S. retail price (deflated), 1959 average U. S. per capita disposable income and 1959 population figures, slightly overestimates the actual consumption of frozen peas for 1959. This, however, does not seriously detract from the solution.

Table 18. Estimated production and shipment pattern for Situation 1[1]

Producing region	Consuming region 1	2	3	4	5	6	7	8	9	10	Totals
	Thousand pounds										
Eastern Oregon		31,188	31,075				5,969	9,425	61,175	19,544	158,376
Maine	28,119										28,119
Western Washington		46,700		7,325			24,175				78,200
Minnesota				12,487	6,088	13,712					32,287
New York		9,094									9,094
Eastern Seashore		18,462									18,462
Totals	28,119	105,444	31,075	19,812	6,088	13,712	30,144	9,425	61,175	19,544	324,538

[1] Assumes the following:
a) Past 3-year average U. S. retail price.
b) 1959 average U. S. per capita disposable income.
c) 1959 regional population.
d) 1959 cost or supply relationships.

Table 19. Estimated production and shipment pattern for Situation 2[1]

Producing region	Consuming region 1	2	3	4	5	6	7	8	9	10	Totals
	Thousand pounds										
Eastern Oregon		9,538	37,600				19,581	10,519	80,988	24,519	182,745
Maine	31,212										31,212
Western Washington		81,100		5,150			13,600				99,850
Minnesota				16,544	6,650	14,844					38,038
New York		9,838									9,838
Eastern Seashore		21,019									21,019
Totals	31,212	121,495	37,600	21,694	6,650	14,844	33,181	10,519	80,988	24,519	382,702

[1] Assumes the following:
a) Past 3-year average U. S. retail price.
b) 1959 average U. S. per capita disposable income.
c) 1970 estimated regional population.
d) 1959 cost or supply relationships.

pattern is not known. It is, however, the minimum cost pattern that would satisfy the consumption requirements in each region under the supply conditions specified.

Situation 2 projects a pattern of production for 1970, assuming that per capita consumption and income remain the same, but that United States population increases by 27,516,000 people.[17] As indicated in Table 19, production in all areas would expand but at different rates. Western Washington would expand its production the most—27.7%. Next greatest expansion would be in Minnesota—17.8%. Eastern Oregon—15.4%, Eastern Seashore—13.8%, Maine—11.0%, and New York—8.2%. In absolute amounts Eastern Oregon would increase production by 24.3 million pounds, Western Washington by 21.7 million, Minnesota by 5.7 million, Maine by 3.1 million, Eastern Seashore by 2.5 million, and New York by .7 million pounds.

The consumption and shipment pattern for Situation 2 shows that each producing region would supply the same consuming regions as in Situation 1, but the amounts would be different. In Situation 2, for example, Eastern Oregon would increase its shipments to Regions 3, 7, 8, 9, and 10, but reduce substantially its shipments to Region 2. Western Washington would expand its shipments to Region 2 but reduce those to the other two regions.

Situation 3 assumes 1970 conditions with the same population growth as in Situation 2 and an increase in per capita income based on the rate of increase taking place between 1950 and 1960. With these assumptions total United States frozen pea consumption in 1970 would be 486 million pounds or 50% greater than with 1959 income and population (Table 20). Again all producing areas would expand their production, but at different rates. Western Washington would experience the highest rate—69.2%, followed by Eastern Oregon—45.2%, Minnesota—43.4%, Eastern Seashore—41.5%, Maine—41.1%, and New York—32.7%. In absolute amounts, Western Washington would increase from 78 million to 132 million pounds, Eastern Oregon from 158 million to 230 million, Maine from 28 million to 40 million, Minnesota from 32 million to 46 million, New York from 9 million to 12 million, and Eastern Seashore from 18 million to 26 million pounds.

The distribution pattern for Situation 3 is similar to the previous situations, except that the patterns for Eastern Oregon and Western Washington differ. With increased consumption in the West and Southwest, Eastern Oregon no longer would supply Region 2. Except for some product being shipped to Region 3, all of Eastern Oregon's

[17] Projected 1970 regional population estimates are shown in Appendix Table 40.

Table 20. Estimated production and shipment pattern for Situation 3[1]

Producing region	Consuming region 1	2	3	4	5	6	7	8	9	10	Totals
	Thousand pounds										
Eastern Oregon			42,194				40,275	13,369	102,944	31,162	229,944
Maine	39,669										39,669
Western Washington		116,225	5,600	8,600			1,900				132,325
Minnesota				18,969	8,456	18,862					46,287
New York		12,069									12,069
Eastern Seashore		26,131									26,131
Totals	39,669	154,425	47,794	27,569	8,456	18,862	42,175	13,369	102,944	31,162	486,425

[1] Assumes the following:
a) Past 3-year average U. S. retail price.
b) 1970 estimated average U. S. per capita disposable income.
c) 1970 estimated regional population.
d) 1959 cost or supply relationships.

Table 21. Estimated production and shipment pattern for Situation 4[1]

Producing region	Consuming region 1	2	3	4	5	6	7	8	9	10	Totals
	Thousand Pounds										
Eastern Oregon		21,088	31,075				5,969	9,425	61,175	19,544	148,276
Maine	28,119										28,119
Western Washington		50,200		3,825			24,175				78,200
Minnesota				15,988	6,088	13,712					35,788
New York		10,581									10,581
Eastern Seashore		23,575									23,575
Totals	28,119	105,444	31,075	19,813	6,088	13,712	30,144	9,425	61,175	19,544	324,539

[1] Assumes the following:
a) Past 3-year average U. S. retail price.
b) 1959 average U. S. per capita disposable income.
c) 1959 regional population.
d) 1959 cost or supply relationships except that transportation costs are increased by 50% from all producing areas to all consuming areas.

production would go to the South, Southwest, and West. Western Washington, however, supplies Region 2 quite heavily and ships some product to Region 3. The nature of the distribution patterns in Situations 1, 2, and 3, and others to be presented later suggest that the markets for the two areas of the Northwest tend to be somewhat interchangeable. This is due, no doubt, to their geographical proximity and the similarity in transportation costs from these two areas to the various markets.

Situations with varying supply conditions

Situations 4, 5, and 6 show the effects upon production and shipment patterns of changes in supply conditions when demand and consumption are held constant at the Situation 1 level. The sensitivity of these patterns to changes in transportation costs, technology, and supply elasticities will be illustrated.

In Situation 4 transportation costs are assumed to increase by 50% from all producing regions to all consuming regions, while all other conditions remain the same as in Situation 1. It would be expected that constant percentage increases in transportation costs would shift production from the more distant areas to those located nearer the larger consuming centers. Production increases would in fact be called for in Minnesota, New York, and the Eastern Seashore (Table 21). Production in Maine, however, would remain the same as in Situation 1. Apparently transportation rates from Maine are influenced to a greater degree than those in other areas by factors other than distance.

It also would be expected that decreases in production would have taken place in both Eastern Oregon and Western Washington. Table 21 indicates that only Eastern Oregon had a decrease in production while Western Washington remained at the same level of production as in Situation 1. This can be explained by discontinuities in the supply functions. One segment of the supply curve in Eastern Oregon dropped out first and this was sufficient to permit the increase in production in the eastern areas brought about by the change in transportation costs. Western Washington had a decrease in shipments to Region 4, and this permitted a lower segment of its supply curve to satisfy demand in Region 2. Had the segments of the supply curve been made smaller to more nearly approach a continuous supply function, a decrease would have occurred in both producing areas of the Northwest.

Situation 4 illustrates one other point. The more relatively inelastic the supply function for an area near a large consuming center, the smaller will be the increase in production in that area resulting from "across the board" percentage increases in transportation rates.

Conversely, the smaller will be the decrease in production for the area located a great distance from the consuming center.

Situation 5 was included in the study to show the effect upon the production pattern resulting from a cost reducing change in technology and a consequent shift in the supply curve. Two kinds of technology changes must be recognized. Those that can and will be adopted in all areas have little effect on production patterns, while those that cannot be adopted in all areas would affect the production pattern. In Situation 5 it has been assumed that a new pea variety increases yields by 25% in New York, Minnesota, Maine, and the Eastern Seashore but is not adapted to Western Washington and Eastern Oregon. This causes reduced costs of production and a shift in the supply function for the areas adopting the new variety. The result as shown in Table 22 is a substantial increase in production in the four areas experiencing the change in technology and a decrease in the remaining two areas. New York would expand its production over that shown in Situation 1 by 33%, Minnesota by 36%, Maine by 21%, and the Eastern Seashore by 42%. Production of Eastern Oregon and Western Washington would be reduced by 11 and 14%, respectively.

Situation 6 measures the amount of divergence between the production pattern under conditions of single supply prices for each region and the production pattern arising when some degree of elasticity has been given to the supply functions as in Situations 1 through 5 above. This situation is intended to demonstrate, in a more general sense, the importance of supply and demand elasticities upon interregional competition analyses and the possible effect on solutions of simplifying assumptions with regard to supply and demand elasticities.

Conditions of demand for this situation are the same as those for Situation 1, but single supply prices (perfectly elastic supply functions) for each region are used. These are based upon the total of single point costs of production, processing, transportation, and distribution as estimated in this study, and they assume that any area could supply unlimited quantities of peas at its single supply price.

In this situation the consumption needs of each consuming region are filled by the regions producing, processing, and shipping at the lowest total costs. Under these conditions any producing region could expand production to supply all consuming regions if necessary.

The production pattern shown in Table 23 for this situation indicates that only three of the six production regions—Eastern Oregon, Maine, and Minnesota—would remain in production. The other three regions—New York, Western Washington, and Eastern Seashore—would produce none. A comparison of the results from Situa-

Table 22. Estimated production and shipment for Situation 5[1]

Producing region	Consuming region										
	1	2	3	4	5	6	7	8	9	10	Totals
					Thousand pounds						
Eastern Oregon		14,100	31,075				5,969	9,425	61,175	19,544	141,288
Maine	28,119	5,769									33,888
Western Washington		47,375					20,000				67,375
Minnesota				19,812	6,088	13,712	4,175				43,787
New York		12,069									12,069
Eastern Seashore		26,131									26,131
Totals	28,119	105,444	31,075	19,812	6,088	13,712	30,144	9,425	61,175	19,544	324,538

[1] Assumes the following:
a) Past 3-year average U. S. retail price.
b) 1959 average U. S. per capita disposable income.
c) 1959 regional population.
d) 1959 cost or supply relationships except that yields were increased by 25% in New York, Minnesota, Maine, and the Eastern Seashore while those of the other areas were held constant.

Table 23. Estimated production and shipment pattern for Situation 6[1]

Producing region	Consuming region										
	1	2	3	4	5	6	7	8	9	10	Totals
					Thousand pounds						
Eastern Oregon				19,812		13,712	30,144	9,425	61,175	19,544	153,812
Maine	28,119	105,444	31,075								164,638
Western Washington					6,088						6,088
Minnesota											
New York											
Eastern Seashore											
Totals	28,119	105,444	31,075	19,812	6,088	13,712	30,144	9,425	61,175	19,544	324,538

[1] Assumes the following:
a) Past 3-year average U. S. retail price.
b) 1959 average U. S. per capita disposable income.
c) 1959 regional population.
d) Single supply prices (perfectly elastic supply functions) based on 1959 costs were used for each region.

tions 1 and 6 shows that the production patterns for the two situations, differing only with respect to assumptions concerning supply elasticities, are quite different (Table 24). For example, with the supply elasticities used in Situation 1, it was estimated that Maine would produce 28 million pounds of frozen peas, while in Situation 6, using the assumption of perfectly elastic supply functions, it was estimated that Maine would produce almost 165 million pounds. This substantial difference in the estimated production pattern leads one to the conclusion that supply elasticities (and demand elasticities as well) are extremely important in this type of analysis.

Table 24. Comparison of regional production patterns for frozen peas obtained in Situations 1 and 6

Producing region	Production of frozen peas		
	Situation 1	Situation 6	Difference
	Thous. lbs.	*Thous. lbs.*	*Thous. lbs.*
Eastern Oregon	158,376	153,812	4,564
Maine	28,119	164,638	–136,519
Western Washington	78,200	0	78,200
Minnesota	32,287	6,088	26,199
New York	9,094	0	9,094
Eastern Seashore	18,462	0	18,462
Totals	324,538	324,538	

It is presumed that Situation 1 is the more valid because it corresponds more closely with the pattern that existed in the industry in 1959. It would appear that any interregional competition analysis designed for the purpose of predicting future patterns of production and development must first be capable of explaining what actually exists in the industry.

Model II

The application of Model II to the problem of interregional competition is not intended to produce practical results, but is designed primarily to bring into focus certain methodological problems. It further will demonstrate that (1) theoretical models developed under assumptions of perfect competition need to be modified for use in interregional competition research, and (2) that Model II may prove to be a useful tool for other problem areas to be investigated.

Model II is more of a general-equilibrium type than is Model I and differs in the following manner:

1. Both supply and demand functions are segmented in the linear programming model, while only the supply function was segmented in Model I.

2. It not only determines the optimum pattern of production and shipment, but also the amount to be consumed in each region and the equilibrium prices that should prevail under conditions assumed. The equilibrium price is located at the intersection of the industry demand and supply curves.

In order to incorporate some of the changes discussed above, it was necessary to bring demand prices more explicitly into the analysis. In Model I, prices were used only in estimating (through the demand function) the levels of consumption for the model. In Model II supply prices for each segment of the regional supply schedules are subtracted from the demand prices for each segment of the demand schedule. As a result the production pattern is determined by both demand and supply relationships. If a perfectly competitive pattern of prices (uniform prices for all regions varying by not more than the amount of transportation costs) had been used in deriving the approximated regional demand schedules, the solution reached for a given level of consumption would be expected to coincide with that obtained in Model I. An imperfectly competitive price pattern was used, however, and this was expected to alter the solution.

There is little basis for using the perfectly competitive price pattern if this pattern does not exist in reality. If the existing pattern of prices among regions were used (assuming that data are available and that they accurately reflect prices prevailing in each region), the solution still would be of little significance because the equilibrium point generated from this model would not necessarily be the point toward which the industry would gravitate.

Because of computer limitations, the demand schedule for each region in Model II was segmented into five steps and the supply schedule into four. This meant that the 17 segments of each supply schedule used in Model I had to be aggregated into 4 segments, thus making the supply relationships more discontinuous. The resulting matrix was of size 24 x 31. This was near the maximum size that could be solved by the computer available.

The solution reached by maximizing this matrix shows that in order for equilibrium to be reached, total production and consumption of peas would be increased from the 324 million pounds in Situation 1 to 356 million pounds (Table 25). The percentage of total production being produced by each region remains fairly constant for the

Table 25. Estimated production and shipment pattern for Model II[1]

Producing region	Consuming region										
	1	2	3	4	5	6	7	8	9	10	Totals
					Thousand pounds						
Eastern Oregon		73,244	32,469	18,912			8,944	9,425	19,331	11,169	173,494
Maine	30,656										30,656
Western Washington		14,150	1,412	1,788			9,719	850	50,094	11,012	89,025
Minnesota					6,638	14,950	14,200				35,788
New York		9,094									9,094
Eastern Seashore		18,462									18,462
Totals	30,656	114,950	33,881	20,700	6,638	14,950	32,863	10,275	69,425	22,181	356,519

[1] Assumes the following:

a) Average regional pattern of retail prices reported for crop years 1950-51 through 1959-60. (See Tables 7 and 9.)
b) 1959 average U. S. per capita disposable income.
c) 1959 regional population.
d) 1959 cost or supply relationships.

two models, but the distribution patterns differ. In comparing the solution to Situation 1 of Model I (Table 18) with that of Model II (Table 25) it can be seen that Maine, New York, and Eastern Seashore supply the same markets with approximately the same quantities. The differences occur with respect to the markets supplied by the other three regions—Eastern Oregon, Western Washington, and Minnesota.

Model II may prove to be useful in two general approaches to future research. More realistic choice indicators than "net social payoff" might be used in predicting the future performance of the industry. No attempt is made here to select or develop these indicators because this is beyond the scope of this study. If this were to be done, any existing market imperfections would have to be identified and quantified in a form suitable for incorporation into the model. This should lead to more refined demand and supply relationships and an improved performance of the model.

The second use of Model II may be in the area of judging the comparative performance of the industry under imperfectly competitive conditions and competitive conditions. Differences between the two would require explanation and would suggest the effects of existing imperfections.

The use of Model II in the present study confirmed the production pattern of the earlier model. It also provided empirical evidence that the pattern of distribution and to a lesser extent the amount of production may be affected by imperfect markets and pricing practices. These findings should be incorporated into future work on this problem.

Conclusions

Implications to Industry

The results of this research indicate that the northwest frozen pea industry currently is in a relatively strong competitive position and that this is likely to continue into the foreseeable future.

This area now produces and processes over 65% of the nation's frozen peas. This allocation under present conditions agrees closely with the optimum pattern of production shown by the analysis. This suggests that the current position of the Northwest is relatively favorable when compared to other areas. Population and incomes are expected to increase in the decade ahead, and this will lead to an increased consumption of frozen peas. Assuming no significant changes in the regional structure of relative cost and supply relationships, the analysis shows that this increase in consumption will be satisfied by an expansion of production in all producing areas with the largest increase occurring in the two northwest areas. This will be especially true with a continuation of the present trend in the westward shift of population.

Technological changes and innovations of the future can be forecast only imperfectly. In an alert and progressive industry such as the pea industry these will occur frequently and can lead to shifts in the present pattern of production. This study shows the effect such changes could have upon the pattern of production. This information could be useful to the industry in adjustments in the future.

The study demonstrates the complexity of interregional competition and the interrelationships and interdependence of the various segments comprising the industry. It shows in particular that changes in costs or supply prices in one area relative to others, whether they be in the realm of production, processing, or transportation costs, will affect its competitive position. In some cases the margin of advantage or disadvantage is quite small and minor changes in the above relationships have an important impact on the competitive position of the various regions.

The analysis perhaps is not as conclusive relative to the pattern of distribution or shipment. The latter is affected by imperfect markets and pricing practices which have not been considered in this study. Shipment patterns developed in Model I show, however, the markets that would be supplied by each producing region under conditions of minimizing costs. These offer some guidelines with respect to the markets that can be supplied at the lowest cost by each producing area.

Methodological Considerations

This analysis provides an empirical basis for the conclusion that results from interregional competition research are highly sensitive to elasticities of supply and demand. Two estimates of regional supply relationships are used in Model I to demonstrate the effect of differences in regional supply elasticities on the interregional pattern of production. The inference that there is a difference in results of the interregional competition model brought about by differences in supply and demand elasticities does not necessarily hinge on the accuracy of the estimates made in this study.[18] The usefulness of interregional competition analysis as a tool to predict future patterns of develop-

[18] As was pointed out earlier, a lack of regional data forced the use of some rather naive approximations in estimating regional demand and supply functions and these are recognized as having limitations.

ment may well depend on the ability to estimate and incorporate regional demand and supply relationships into the model with accuracy.

The usefulness of Model II was not fully explored, but it appears that it may have a more general application than Model I. It is possible with this model to include sloping demand and supply functions simultaneously. It may prove to be a useful analytical tool for solving problems such as those relating to imperfections in the market. The use of this model should be explored further to determine its capabilities and limitations.

Appendix A
Regional Production Cost Estimates

Data used in estimating production costs in the six major pea-freezing areas were obtained from grower group meetings, processor field men, county agricultural agents, and state agricultural colleges in each area.[1] Growers at the group meetings estimated physical requirements, yields, and local prices of all inputs in their areas and this formed the basis of the cost estimates. This information then was reviewed with processor fieldmen and agricultural college personnel in the different regions for accuracy and representativeness.

The following tables summarize these cost estimates. The assumptions and conditions under which these costs were estimated are not presented here because of space limitations, but they can be found in an existing publication (38).

Appendix Table 1. Estimated yields and costs of producing peas for freezing in major producing areas, 1958

Area	Estimated yields per acre	Estimated production costs[1]		
		Per acre	Per ton	Per cwt.
	Pounds			
Eastern Oregon	2,200	$ 82.52	$ 75.02	$ 3.75
Maine	2,700	101.53	75.20	3.76
Western Washington	4,000	174.26	87.13	4.36
Minnesota	2,200	102.68	93.35	4.67
New York	2,200	106.64	96.95	4.85
Eastern Seashore	2,400	162.31	135.26	6.76

[1] Includes estimated cost of all input requirements including labor, equipment expense, seed, fertilizer, insecticides, land, overhead, and a custom charge for harvesting and vining.

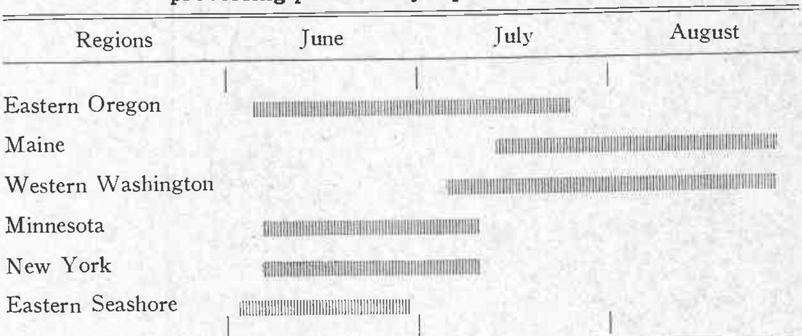
[1] Other sources used include results from a recent individual grower interview in Minnesota and results from a study published by the Maine Agricultural Experiment Station (64).

Appendix Table 2. Component breakdown of estimated costs of producing peas for freezing in major producing areas, 1958

Item	Eastern Oregon	Maine	Western Wash.	Minn.	New York	Eastern Seashore
			Cost per acre			
Labor	$ 4.30	$ 7.60	$ 7.10	$ 5.06	$ 4.79	$ 4.66
Tractor	7.67	6.07	5.08	4.78	4.38	4.19
Other equipment	2.55	3.46	5.08	3.39	3.20	3.46
Cover crop	....	....	8.00	....	....	....
Seed	17.00	29.40	25.00	29.00	33.77	45.00
Fertilizer and lime	....	8.25	25.00	5.20	15.00	50.00
Weed and insect control	3.50	3.50	16.00	11.00	3.50	11.50
Land	23.00	10.25	35.00	17.25	14.00	15.50
Overhead[1]	2.00	3.00	3.00	3.00	3.00	3.00
Total growing costs	60.02	71.53	129.26	78.68	81.64	137.31
Custom swathing, loading, hauling, and vining	22.50	30.00	45.00	24.00	25.00	25.00
Total estimated costs	$82.52	$101.53	$174.26	$102.68	$106.64	$162.31

[1] An allowance for electricity, telephone, liability insurance, truck and car expense, and office supplies.

Appendix Table 3. Usual dates and length of season for harvesting and processing peas in major producing areas[1]



[1] The principal varieties of peas produced for freezing are Thomas Laxton, Freezer 37, and the Perfection varieties. These are grown in all areas and differ from canning varieties.

Appendix Table 4. Typical acreages of total cropland and of peas per farm in major producing areas, 1958

Regions	Cropland per farm	Peas per farm
	Acres	*Acres*
Eastern Oregon	500	160
Maine	120	30
Western Washington	100	50
Minnesota	160	12
New York	180	20
Eastern Seashore	150	25

Appendix Table 5. Typical implements used in the production of peas for freezing in major producing areas, 1958

Implement	Eastern Oregon	Maine	Western Washington	Minnesota	New York	Eastern Seashore
5-plow crawler type tractor	X					
3-plow tractor		X	X	X	X	X
3-16″ plows			X	X	X	X
5-16″ plows	X					
12′ disk		X	X	X	X	X
21′ disk	X					
10′ field cultivator		X				
20′ harrow		X	X	X		X
40′ harrow	X					
16′ springtooth harrow					X	
30′ springtooth harrow	X					
10′ drill		X	X	X	X	X
10′ fertilizer distributor		X	X	X	X	X
30′ drill	X					
12′ roller					X	
24′ roller	X					
12′ drag			X			
30′ rodweeder	X					

Appendix Table 6. Estimated time requirements for performing tillage operations normally practiced in producing peas in major producing areas, 1958[1]

Operation	Eastern Oregon	Maine	Western Washington	Minnesota	New York	Eastern Seashore
	Man hours per acre one time over[2]					
Plow	.67	......	1.00	1.00	1.00	1.00
Disk	.33	.40	.40	.40	.40	.40
Harrow (springtooth)	.18	......	......	......	.20	......
Harrow (spiketooth)	.10	.20	.20	.20	......	.20
Field cultivator	......	.40	......	......	......	......
Rod weed	.15	......	......	......	......	......
Drill	.30	2.00[3]	.66	.66	.66	.66
Roll	.15	......	......	......	.33	......
Float	......	......	.20	......	......	......
Pick up stones	......	2.00	......	......	......	......
Fertilize	......	1.00	1.00	1.00	1.00	1.00

[1] Wage rates of $1.35 per hour for Western Washington, $1.25 for Eastern Oregon, and $1.00 per hour for all other areas have been assumed. Labor costs for above operations were determined by applying the appropriate wage rate to the time required.

[2] For number of times each operation was performed see Appendix Table 7.

[3] Includes liming.

Appendix Table 7. Tillage operations normally practiced in producing peas in major producing areas, 1958

Operation	Area					
	Eastern Oregon	Maine	Western Washington	Minnesota	New York	Eastern Seashore
	Number of times operation was performed					
Disk	1	2	3	2	1	2
Plow	1	–	1	1	1	1
Field cultivator	–	–	–	–	–	–
Harrow	3	2	1	3	–	3
Springtooth harrow	3	–	–	–	2	–
Rod weed	1	–	–	–	–	–
Fertilize	–	1	1	1	1	1
Float	–	–	1	–	–	–
Drill	1	1	1	1	1	1
Roll	1	–	–	–	1	–
Weed spray	–	1	1	1	1	1
Aphid spray	1	–	1	1	–	1
Pick up stones	–	1	–	–	–	–

Appendix Table 8. Annual costs for equipment used in growing peas in major producing areas, 1958

Implement	Size	Replacement cost[1]	Estimated life	Season's fixed costs: Depreciation[2]	Interest on investment[3]	Taxes, insurance, & shelter[4]	Total	Season's variable costs: Repairs, lubrication, oil, etc.[5]	Fuel[6]	Totals
Tractor, crawler type	5-plow	$10,000	15	$667	$300	$200	$1,167	$1,000	$512	$1,512
Tractor, wheel	3-plow	4,000	15	267	120	80	467	400	320	720
Plows, moldboard	5-16″	1,005	10	101	30	20	151	101	......	101
Plows, moldboard	3-16″	635	10	64	19	13	96	64	......	64
Disk, tandem	12′	730	10	73	22	15	110	37	......	37
Disk, tandem	21′	1,425	10	143	43	29	215	71	......	71
Field cultivator	10′	420	10	42	13	8	63	21	......	21
Harrow, spiketooth	20′	170	15	11	5	3	19	3	......	3
Harrow, spiketooth	40′	340	15	23	10	7	40	7	......	7
Harrow, springtooth	16′	310	15	21	9	6	36	6	......	6
Harrow, springtooth	30′	580	15	39	17	12	68	12	......	12
Drill	10′	655	15	44	20	13	77	33	......	33
Drill	30′	1,965	15	131	59	39	229	98	......	98
Fertilizer distributor	10′	345	10	35	10	7	52	17	......	17
Roller, single	12′	380	15	25	11	8	44	8	......	8
Roller, single	24′	800	15	53	24	16	93	16	......	16
Drag	12′	80	10	8	2	2	12	4	......	4
Rodweeder	36′	900	10	90	27	18	135	45	......	45

[1] The same replacement costs were used for all areas. Although they do vary somewhat between areas, the differential is so small that they affect per acre costs only slightly.
[2] Based on straight line depreciation of replacement cost.
[3] Interest on investment—3% of replacement cost which is about 5.5% of average investment.
[4] Taxes, insurance, and shelter—2% of replacement cost.
[5] Repairs, lubrication, oil, etc.—estimated as 10% of replacement cost for tractors and plows, 2% for rollers and harrows, and 5% for all other equipment.
[6] Based on (a) an hourly fuel consumption of 2.5 gallons for the wheel tractor and 4.0 gallons for the crawler tractor, (b) a uniform cost of 16¢ per gallon for diesel fuel (fuel prices varied only slightly between areas), and (c) 800 hours of operation per year.

Appendix Table 9. Seeding rates and costs per acre in major producing areas, 1958

Area	Seeding rate	Cost of seed	
	Lbs.	*Per lb.*	*Per acre*
Eastern Oregon	170	$ .10	$17.00
Maine	196	.15	29.40
Western Washington	250	.10	25.00
Minnesota	200	.145	29.00
New York	252	.134	33.77
Eastern Seashore	300	.15	45.00

Appendix Table 10. Common fertilizer applications used in growing peas in major producing areas, 1958[1]

Area	Common fertilizer applications
	Per acre
Eastern Oregon	None
Maine	150 lbs. of ammonium nitrate 500 lbs. of lime
Western Washington	150 lbs. of potash, 200 lbs. of treble superphosphate 15 lbs. of magnesium and ¾ ton of lime
Minnesota	100 lbs. of 0-20-10 1 ton of lime (applied every 2 years)
New York	500 lbs. of 10-10-10
Eastern Seashore	1,200 lbs. of 5-10-10 400 lbs. of cyanamide 1½ tons of lime (applied every 3 years)

[1] These are estimates of the most common applications and are not fertilizer recommendations for any farm or area. Fertilizer requirements should be determined by soil analysis.

Appendix Table 11. Estimated annual cost of land used for growing peas in major producing areas, 1958

Area	Current estimated market value of typical pea land	Estimated taxes	Total annual land costs[1]
	Per acre	*Per acre*	*Per acre*
Eastern Oregon	$360.00	$5.00	$23.00
Maine	125.00	4.00	10.25
Western Washington	550.00	7.50	35.00
Minnesota	265.00	4.00	17.25
New York	200.00	4.00	14.00
Eastern Seashore	500.00	6.00	31.00[2]

[1] Includes interest at 5% and taxes.
[2] Only one half of this was charged to peas because land is double cropped.

Appendix B
Regional Processing Cost Estimates

Processing costs are based upon a synthesized analysis of economic engineering studies conducted in 10 pea-freezing plants in the Northwest.[1] In these plants, time and production studies were made of actual jobs and machine operations. In addition, accounting records and interviews with management and supervisory personnel were utilized to provide further information on physical requirements and input costs. Equipment manufacturers, material suppliers, and other related concerns also were sources of information.

Processing cost relationships for the other areas have been estimated through appropriate adjustments in the costs established for plants in the Northwest.[2] These included adjustments for regional differences in prices paid for labor, electricity, water, packaging materials and other cost items, length of operating season, and the use of equipment for processing other products.

Labor

Estimated costs of labor required for processing and freezing peas are based on (1) labor standards for each of the job operations involved in processing and (2) typical current wage rates being paid in each region for performing these jobs.

Labor standards were developed from time and production studies made to determine the amount of work time required per unit of product for each job. An "allowance" deemed reasonable by industrial engineers for delays and rest periods was added to the work time. Total time required was then converted to number of units of product per man-hour (Appendix Table 12). Labor standards calculated in this manner represent the output a worker is able to achieve

[1] An excellent treatment of the theory and methodology of the synthetic method of estimating costs for a firm has been presented by French, Sammet, and Bressler (26, pp. 543-721). A limitation of the synthetic method is that synthesized cost estimates cannot be tested by the standard measures of statistical reliability. Estimates from synthetic construction can only be checked by comparing results with alternative sources of information. Black discussed this point in the Journal of Farm Economics (5, p. 275).

[2] Observations of plant operations and interviews with plant personnel in the other areas indicated that plant operations and techniques in these areas were very similar to those in the Northwest. This seems to be a reasonable conclusion in view of the small number of firms supplying processing and freezing equipment to the national market.

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Vining and receiving				
Swath vines Operates swather and cuts and swaths peas as required ahead of loader. Adjusts blade weight for optimum cutting, and assists in servicing machine.	5,000	2	4	6
Load vines Drives tractor and operates loader to load vines onto trucks. Positions truck drivers as they move alongside the loader for proper loading.	5,000	2	4	6
Cut and load vines[1] Operates tractor and combination loader and swather. Adjusts blade for proper cutting, and positions truck drivers for proper loading.	2,500	4	8	12
Loader mechanic Watches mechanical functioning of loaders and swathers, and performs necessary repairs and maintenance.	10,000	1	2	3
Clean up field Picks up vines missed by loader with fork, and performs miscellaneous tasks in field.	10,900	1	2	3
Operate electric forks Engages vines with electric forks, and places fork load of vines on viner food conveyor.	1,600	7	13	19
Clean up around viners Cleans up and performs miscellaneous tasks around viners.	3,200	4	7	10

[1] Some areas use the combination swather and loader instead of separate swathing and loading machines.

[2] Vining stations with a maximum of 16 viners are assumed for Eastern Oregon and Washington. For the smaller acreages and more scattered operations in the other areas, vining stations with a maximum of 8 viners are assumed. This creates two sets of standards and thus affects crew sizes. The first line applies to operations assuming stations of 8 viners and the second to operations with 16 viners.

[3] For outputs of 10,000 pounds per hour or less, these jobs are performed by other personnel not being fully utilized at these low rates of operation.

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output (Cont.)

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Vining and receiving (Cont.)				
Operate caterpillar[2] Operates caterpillar tractor with dozer blade, and distributes vines (from the vine discharge belt) evenly throughout the ensilage pit. Also packs vines with tracks of caterpillar.	5,000 (10,000)	2 (1)	4 (2)	6 (3)
Operate tractor[2] Operates tractor with fork or blade, and positions vines for forkers; also spots loads of incoming vines.	5,000 (10,000)	2 (1)	4 (2)	6 (3)
Viner mechanic Watches mechanical functioning of viners, and performs necessary repairs and maintenance.	3,200	4	7	10
Fill and load bins[2] Unloads empty bins from truck, positions bin under conveyer chute, regulates filling, and loads on truck or sets aside for temporary storage. Also performs miscellaneous cleanup duties.	5,000 (8,300)	2 (2)	4 (3)	6 (4)
Weigh trucks Directs trucks onto truck scale, operates scale, and records gross and net weight.	30,000	1	1	1
Operate tenderometer Takes samples of peas for grading, operates tenderometer, and performs other grading tasks. Records results.	30,000	1	1	1
Operate clipper cleaners Operates clipper cleaners, regulates flow of product, cleans equipment, and performs minor housekeeping duties.	7,500	2	3	4

[2] See footnote two on page 63.

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output (Cont.)

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Vining and receiving (Cont.)				
Dump bins Helps to place full bin onto cradle dump, operates dump, and removes empty bin.	39,800	1	1	1
Wash bins Positions empty bins for washing, washes bins, and removes bins to temporary storage or sets where lift truck operator can pick them up for loading. Performs minor housekeeping duties.	30,700	1	1	1
Operate fork lift truck[3] Operates lift truck, unloads full bins from truck, sets aside to temporary storage, loads empty bins on truck for return to vining station, positions full bins for dumping.	38,500	..	1	1
Field foreman[2] Supervises field operations, coordinates with vining station foreman, and works closely with fieldman with respect to maturity, time of harvest, etc.	20,000 (30,000)	1 (1)	1 (1)	2 (1)
Viner set foreman[2] Supervises vining station crew and operation. Coordinates with plant and field activities.	5,000 (10,000)	2 (1)	4 (2)	6 (3)
Preparation				
Operate flotation cleaner Operates flotation cleaners, regulates flow of product, cleans equipment, and performs minor housekeeping duties.	15,000	1	2	2
Operate blancher Operates blancher, maintains proper blanching temperature, regulates product through blanchers.	30,000	1	1	1

[2] See footnote two on page 63.
[3] See footnote three on page 63.

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output (Cont.)

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Preparation (Cont.)				
Operate grader Operates quality graders, maintains proper brine concentration, services equipment, and regulates flow of product.	30,000	1	1	1
Mix brine Mixes brine solution and does minor housekeeping duties.	30,000	1	1	1
Sort and inspect Inspects peas on inspection belt. Removes defects, off-colors, skins, and foreign material.	1,000	10	20	30
Pump and scavenger reel maintenance[3] Attends pumps, draining reels, return water mechanism, etc. Makes necessary repairs and maintenance to this equipment.	30,000	..	1	1
Clean-up Keeps area around preparation equipment free of debris, and performs minor miscellaneous duties.	15,000	1	2	2
Mechanic Watches mechanical functions of preparation, and performs necessary repairs and maintenance.	20,000	1	1	2
Foreman Supervises receiving and preparation of peas for freezing.	30,000	1	1	1
Forelady Supervises hand sorters on inspection belt. Also performs inspection and sorting activities in spare time.	30,000	1	1	1
Quality control Takes required samples of peas at various points in the preparation stage, and performs specified quality control checks. Records results.	10,000	1	2	3

[3] See footnote three on page 63.

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output (Cont.)

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Packaging, casing, and freezing				
Operate former and filler Operates and controls former, filler, and closer, and gets flat packages from carton and places in forming machine.	10,125	1	2	3
Operate wrapper and inspect packages Controls operation of wrapper, removes over-under packages from packaging line, and regulates the flow of packages into the wrapper.	5,070	2	4	6
Wrapper mechanic Services and adjusts wrapper, keeps wrapper supplied with overwraps, and gets rolls of overwrap from temporary storage.	10,125	1	2	3
Fill tray Gets and places tray, groups and slides packages onto tray, and moves filled tray.	2,550	4	8	12
Load freezer Gets and places trays in freezer doors, and adjusts controls of freezer.	6,450	2	4	5
Unload freezer Takes trays out of freezer and places on conveyor, opens and closes freezer doors, and adjusts controls of freezer.	7,050	2	3	5
Dump tray Gets, dumps, and disposes tray, and operates belt to dumping table.	6,600	2	4	5
Return empty trays Takes full tray-racks of empty trays from tray-dumping station to tray-filling stations, and returns empty tray-racks to tray-dumping station.	10,125	1	2	3

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output (Cont.)

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Packaging, casing, and freezing (Cont.)				
Adjust flow of packages to automatic caser Regulates flow of product from tray-dumping station into single line load-in conveyor to automatic caser.	6,600	2	4	5
Form case and operate automatic caser Gets and forms case, puts on caser, and gets supplies.	6,015	2	4	5
Fold flaps and code case Folds flaps of case to close, codes case with hand stamp, and pushes case toward sealer and compressor.	6,015	2	4	5
Load pallet and operate sealer Gets and stacks cases onto pallets, gets and places empty pallets, and services, adjusts, and regulates case sealer.	5,120	2	4	6
Package supply and clean-up Keeps area around packaging and casing equipment clean and free of debris. Keeps former and filler operator and caser supplied with packaging materials from storage.	10,000	1	2	3
Package foreman Supervises and coordinates packaging, freezing, and casing operations.	30,000	1	1	1
Package forelady[3] Supervises female workers performing packaging and casing operations. Generally assists the package foreman.	30,000	..	1	1

[3] See footnote three on page 63.

Appendix Table 12. Labor standards of production and number of workers required for jobs performed in processing frozen peas in plants with different hourly rates of output (Cont.)

Job classification	Pounds of clean peas per man-hour	Number of workers required for different rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Packaging, casing, and freezing (Cont.)				
Refrigeration engineer Operates freezing facilities, maintains proper temperatures, and performs necessary repairs and maintenance to freezing equipment.	30,000	1	1	1
Assistant refrigeration engineer[3] Assists refrigeration engineer in his duties.	30,000	..	1	1
Quality control Takes required samples of peas at various points without the packaging and freezing process. Performs specified quality control check. Records results.	10,000	1	2	3
Equipment maintenance[3] Watches mechanical functioning of packaging and casing equipment, and performs necessary repairs and maintenance.	30,000	..	1	1
Plate freezer operator Coordinates freezing activities. Determines when product should be moved in and out of freezers.	30,000	1	1	1

[3] See footnote three on page 63.

under conditions of a continuous flow of product and a reasonably efficient use of his time. Labor standards are not based on either the average or the optimum rate of output found in operations studied, but fall between these two points.

The number of workers required for each job was computed by dividing the rate of output of product per hour for the operation by the labor standard (a fraction of a worker was raised to the next whole number). Current regional wage rates and fringe benefits shown in Appendix Table 13 were applied to appropriate labor requirements to determine labor costs.

Equipment

The number of pieces of processing equipment required for different rates of output was estimated from equipment standards developed from time and production studies, manufacturer's specifications, and interviews with plant personnel (Appendix Table 14). Physical requirements were first converted to investment costs. Annual costs of equipment, both fixed and variable, then were estimated. Fixed equipment costs include an allowance for depreciation, taxes, insurance, interest on investment, and fixed repairs and maintenance. Variable costs include the estimated costs of variable repairs and maintenance, power, water, and fuel.

Plant Organization and Cost Stages

For convenience in computing processing costs, the operations of a plant have been grouped into eight stages and regional costs determined for each. These stages are (1) vining; (2) preparation; (3) packaging and freezing; (4) shipping and storage; (5) buildings including water, steam, and electrical facilities; (6) plant management, administrative, and office costs; (7) sales; and (8) purchasing and field expenses. (See Appendix Figures 1 and 2 for the flow pattern of the product and a typical plant layout.)

Stage 1—Vining

Vining is the process of separating the peas from the pods and vines. It begins with the cutting and swathing of the pea vines in the field and ends with the clipper cleaning process in the plant.

Vining costs are affected by many variables as shown in a previous report (10). In the analysis presented here each variable has been held constant at levels selected as being the most representative of conditions in the different areas. The levels selected will not apply to individual plants, but are expected to reflect general cost relationships existing within and among regions.

Appendix Table 13. Estimated regional wage rates by job classification for processing frozen peas, 1959[1]

Job classification	Eastern Oregon	Western Washington	Minnesota	New York	Maine	Eastern Seashore
	Dollars per hour					
Vining and receiving						
Swath vines	1.70	1.70	1.50	------	------	------
Load vines	1.70	1.70	1.50	------	------	------
Cut and load vines	------	------	------	1.30	1.30	1.35
Loader mechanic	2.00	2.05	1.70	1.55	1.55	1.55
Clean up field	1.55	1.60	1.20	1.05	1.05	1.05
Operate electric forks	1.55	1.60	1.20	1.05	1.05	1.05
Clean up around viners	1.55	1.60	1.20	1.05	1.05	1.05
Operate caterpillar	2.00	2.05	1.70	1.55	1.55	1.55
Operate tractor	1.70	1.70	1.50	1.30	1.30	1.35
Viner mechanic	2.00	2.05	1.70	1.55	1.55	1.55
Fill and load bins	1.55	1.60	1.35	1.25	1.25	1.25
Weigh trucks	1.65	1.65	1.35	1.25	1.25	1.25
Operate tenderometer	1.65	1.65	1.35	1.25	1.25	1.25
Operate clipper cleaners	1.65	1.65	1.35	1.25	1.25	1.25
Dump bins	1.55	1.60	1.35	1.25	1.25	1.25
Wash bins	1.55	1.60	1.35	1.25	1.25	1.25
Operate fork lift truck	1.70	1.70	1.50	1.30	1.30	1.35
Field foreman	2.05	2.10	1.75	1.60	1.60	1.60
Viner set foreman	2.05	2.10	1.75	1.60	1.60	1.60
Preparation						
Operate flotation cleaner	1.70	1.70	1.50	1.30	1.30	1.35
Operate blancher	1.70	1.70	1.50	1.30	1.30	1.35
Operate grader	1.70	1.70	1.50	1.30	1.30	1.35
Mix brine	1.55	1.60	1.35	1.25	1.25	1.25
Sort and inspect	1.35	1.35	1.20	1.05	1.05	1.10

Production and processing area: Eastern Oregon, Western Washington, Minnesota, New York, Maine, Eastern Seashore.

[1] Wage rates do not include employer costs and fringe benefits.
Allowances for these were made in the analysis as follows:
Eastern Oregon and Western Washington—12%.
Minnesota, New York, Maine, and Eastern Seashore—10%.

Appendix Table 13. Estimated regional wage rates by job classification for processing frozen peas, 1959[1] (Continued)

Job classification	Eastern Oregon	Western Washington	Minnesota	New York	Maine	Eastern Seashore
			Dollars per hour			
Preparation (cont'd.)						
Pump scavenger reel maintenance	1.55	1.60	1.35	1.25	1.25	1.25
Clean up	1.55	1.60	1.35	1.25	1.25	1.25
Mechanic	2.05	2.10	1.75	1.60	1.60	1.60
Quality control	1.40	1.40	1.25	1.10	1.10	1.15
Forelady	1.50	1.55	1.35	1.15	1.15	1.30
Foreman	2.05	2.10	1.75	1.60	1.60	1.60
Packaging, casing, and freezing						
Operate former and filler	1.35	1.35	1.20	1.05	1.05	1.10
Operate wrapper and inspect packages	1.35	1.35	1.20	1.05	1.05	1.10
Wrapper mechanic	2.00	2.05	1.70	1.55	1.55	1.55
Fill trays	1.35	1.35	1.20	1.05	1.05	1.10
Load freezer	1.55	1.60	1.35	1.25	1.25	1.25
Unload freezer	1.55	1.60	1.35	1.25	1.25	1.25
Dump trays	1.55	1.60	1.35	1.25	1.25	1.25
Return empty trays	1.55	1.60	1.35	1.25	1.25	1.25
Adjust flow of packages to automatic caser	1.35	1.35	1.20	1.05	1.05	1.10
Form case and operate automatic caser	1.35	1.35	1.20	1.05	1.05	1.10
Fold flaps and code case	1.35	1.35	1.20	1.05	1.05	1.10
Load pallet and operate sealer	1.55	1.60	1.35	1.25	1.25	1.25
Package supply and clean up	1.55	1.60	1.35	1.25	1.25	1.25
Plate freezer operator	1.70	1.70	1.50	1.30	1.30	1.35
Equipment maintenance	2.05	2.10	1.75	1.60	1.60	1.60
Fork lift operator	1.70	1.70	1.50	1.30	1.30	1.35
Quality control	1.40	1.40	1.25	1.10	1.10	1.15
Refrigeration engineer	2.25	2.25	1.35	1.75	1.75	1.70
Assistant refrigeration engineer	2.00	2.05	1.70	1.55	1.55	1.55
Package forelady	1.50	1.55	1.35	1.15	1.15	1.30
Package foreman	2.05	2.10	1.70	1.60	1.60	1.60

Appendix Table 14. Equipment requirements for processing frozen peas in 10-ounce packages, 1959[1]

Item of equipment	Estimated replacement cost[2]	Years useful life	Number required for different hourly rates of output: Pounds clean peas per hour 10,000	20,000	30,000
	$				
Vining and receiving					
Swather	6,000.00	10	2	4	6
Loader	3,000.00	10	2	4	6
Swather-loader	5,600.00	10	2	4	6
Tractor (wheel type)	2,625.00	10	2	4	6
Pick-up truck	1,850.00	10	1	1	1[3]
Viner w/electric motor	4,972.63	15	14	26	38
Vine regulator	369.05	15	14	26	38
Electric forks	789.00	15	7	13	19
Oscillating conveyor					
for: 8 viners	2,755.05	15	1	2	4
6 viners	2,405.05	15	1	1	1
4 viners	1,166.25	15	–	1	–
Inclined conveyor (w/ motor and drive)	308.00	15	2	4	5[4]
Shaker (compl. w/ motor)	938.00	15	2	4	5[4]
Tractor (wheel type) w/scoop	3,375.00	10	2	4	5[4]
Tractor (crawler type)	14,000.00	10	2	4	5[4]

[1] Assumes permanent station method of vining, plate freezing, and automatic casing.

[2] F.O.B. manufacturer—to these costs were added estimated installation costs and transportation costs for each area.

Annual equipment costs were calculated as follows:

a. Fixed costs were computed as a percent of installed costs as follows: depreciation—based on years useful life; insurance— 1%; taxes—1%; interest—3% (approximately 5% of undepreciated balance); and fixed repairs—1.5%, except loaders and crawler tractors—3%.

b. Variable costs were computed as follows: variable repairs estimated on basis of 0.5% of installed cost per 100 hours use. See Appendix Tables 19 and 20 for fuel, power, and water consumption and costs.

[3] Two pick-up trucks would be required for these areas where vining stations are assumed to have a maximum of eight viners.

[4] This number would be 6 for those areas where vining stations are assumed to have a maximum of eight viners.

[5] The number of bins would increase with an increase in the number of vining stations. For those areas where vining stations are assumed to have a maximum of eight viners, bin requirements are as follows: 10,000 pounds—32; 20,000 pounds—72; 30,000 pounds—96.

[6] The former, filler, and closer are all leased. Annual fixed costs for these items of equipment are assumed to be the annual rental charge—$2,200. (This varies, based on length of time installed— this is 10-year average.) Variable repairs and maintenance charges are estimated on the basis of an installed cost of $12,000.

[7] Pallets are assumed to be used only once per season and to hold 1,500 pounds of product. Number required will vary with length of season. Requirements shown are for each 100-hours of season length.

Appendix Table 14. Equipment requirements for processing frozen peas in 10-ounce packages, 1959[1] (Continued)

Item of equipment	Estimated replacement cost[2]	Years useful life	Number required for different hourly rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Vining and receiving (Cont.)	$				
Forklift truck (3,000 lb. cap.)	5,500.00	10	1	1	1
Truck scales	3,425.00	15	1	1	1
Tenderometor	1,171.00	15	1	1	1
Bin dumper	800.00	15	2	3	4
Bin washer	500.00	15	1	1	1
Hopper galv. iron 5'x5'x4' w/sloping bottom and feed gate	500.00	15	2	3	4
Bucket elevator	1,380.00	15	2	3	4
Clipper cleaner	2,422.00	15	2	3	4
Bins	113.00	10	24	56	72[5]
Preparation					
Pea washer consisting of long riffle board, flotation washer, and rotary cylinder screen (comp. w/motor and drive)	1,341.00	10	2	3	4
Food pump 3" compl. w/17½"x32" s/s tank and 2 HP motor and drive	824.00	10	2	3	4
Return water screen and supply tank compl. w/ ⅛ HP motor and gear drive	373.00	10	2	3	4
Froth flotation cleaner compl. w/10 HP and ½ HP motor	5,442.00	10	2	3	4
Food pump 3" compl. w/17½"x32" s/s tank, and 2 HP motor and drive	824.00	10	2	3	4
Return water screen and supply tank, compl. w/⅛ HP motor and gear drive	373.00	10	2	3	4
Draining reel compl. w/ ⅓ HP motor and drive and drain pan	740.00	10	2	3	4

[1] See footnote one on page 73.
[2] See footnote two on page 73.
[5] See footnote five on page 73.

Appendix Table 14. Equipment requirements for processing frozen peas in 10-ounce packages, 1959[1] (Continued)

Item of equipment	Estimated replacement cost[2]	Years useful life	Number required for different hourly rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Preparation (Cont.)	$				
Rotary blancher, 18′ compl. w/ s/s feed hopper and discharge chute, 2 HP motor and variable speed drive w/extended drive shaft to run washer	4,540.00	10	2	3	4
Rotary pea washer 7′ long drum compl. w/ sprocket for direct drive from blancher	576.00	10	2	3	4
Food pump, 3″ compl. w/ 17½″x32″ s/s tank and 2 HP motor and drive	824.00	10	2	3	4
Return water screen and supply tank compl. w/ ⅙ HP motor and gear drive	373.00	10	2	3	4
Cooling frame, 8″x7″x 65′ s/s max. of 6 turns, seamed edges	488.00	10	2	3	4
Shaker and drainer compl. w/¾ HP motor and drive	779.00	10	2	3	4
Quality grader and washer compl. w/2′ rod reel and automatic brine density control, 3 HP motor	3,831.00	10	2	3	4
Brine mixing and molding tanks s/s (350 gal. cap.) w/platform, brine control panels and brine recirculating pump	2,300.00	10	1	1	1
Holding bins 5′x4′x4′ galvanized iron, seamed edges	300.00	10	4	6	8
Flumes, 8″x7″x50′ s/s max. of 6 turns, seamed edges	488.00	10	2	3	4

[1] See footnote one on page 73.
[2] See footnote two on page 73.

Appendix Table 14. Equipment requirements for processing frozen peas in 10-ounce packages, 1959[1] (Continued)

Item of equipment	Estimated replacement cost[2]	Years useful life	Number required for different hourly rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Preparation (Cont.)	$				
Shaker and drainer, compl. w/¾ HP motor and drive	779.00	10	2	3	4
Inspection table, 30″x10′ w/3 ply rubber laced belt, angle iron construction w/1 HP motor and drive	1,268.00	10	4	6	8
Tubing, aluminum 3″ 80′ per pump includes bends and couplings	160.00	10	6	9	12
Sewage, screen, pump, and tank	4,800.00	10	1	1	1
Boiler, 125 psi, forced draft gas burner compl. w/fittings, lagging and stack					
108 HP	7,150.00	15	1	–	–
128 HP	8,195.00	15	–	1	–
150 HP	9,195.00	15	–	–	1
Packaging and casing					
Hopper, even feed, galv. iron 27″x30″x24″	115.00	15	1	2	3
Vibrator feeder w/ s/s trough	445.00	10	1	2	3
Former, Filler, Closer } 10-oz. high speed automatic	[6]	[6]	1	2	3
Coder	400.00	10	2	4	6
Metal detecter w/ conveyor belt 3′x6″ on metal stand ⅓ HP gear motor	600.00	10	2	4	6
Package conveyor, 10′ long ⅓ HP motor	400.00	15	2	4	6
Check weight scales 3 lbs. over-under	190.00	10	2	4	6
Wrapper 10-oz. high speed w/6′ receiving belt and 4′ discharge belt	12,150.00	10	2	4	6
Trays, aluminum, holds 30 10-oz. pkgs.	1.30	10	1,064	2,128	3,191

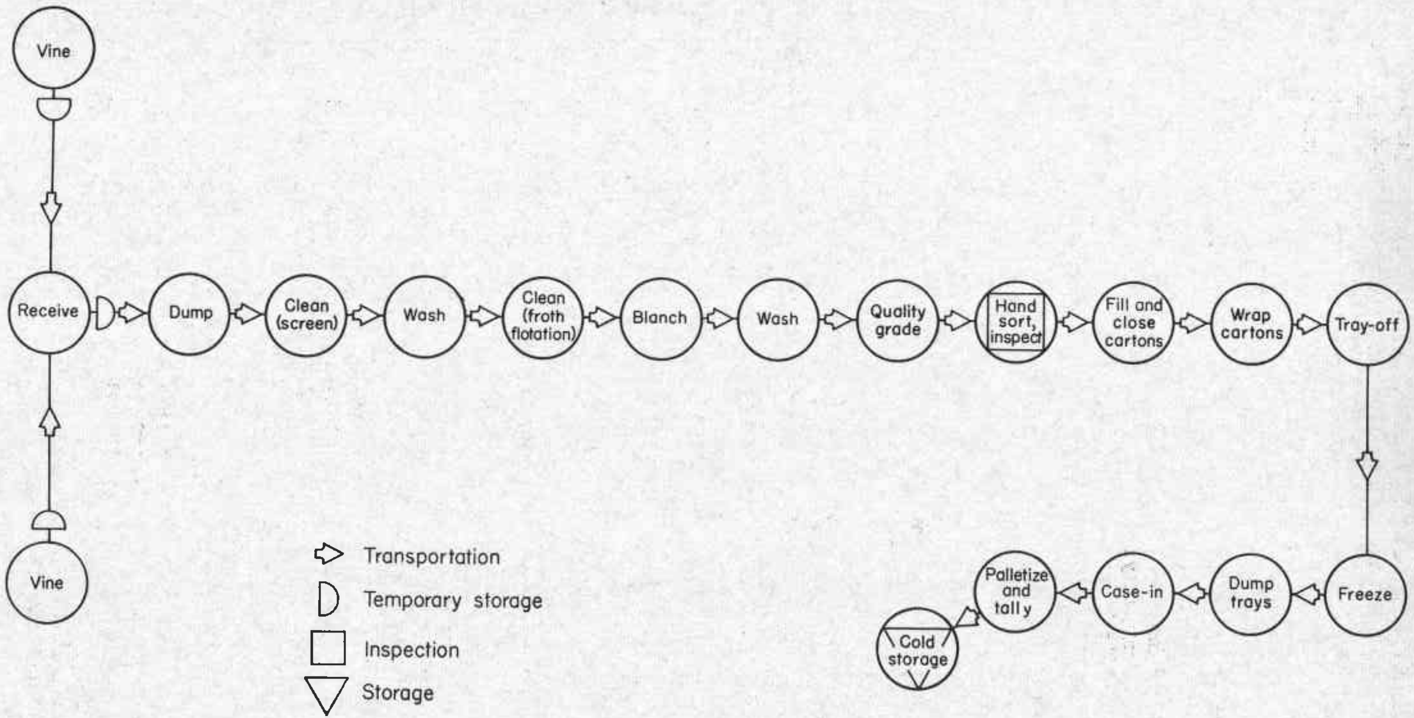
[1] See footnote one on page 73.
[2] See footnote two on page 73.
[6] See footnote six on page 73.

Appendix Table 14. Equipment requirements for processing frozen peas in 10-ounce packages, 1959[1] (Continued)

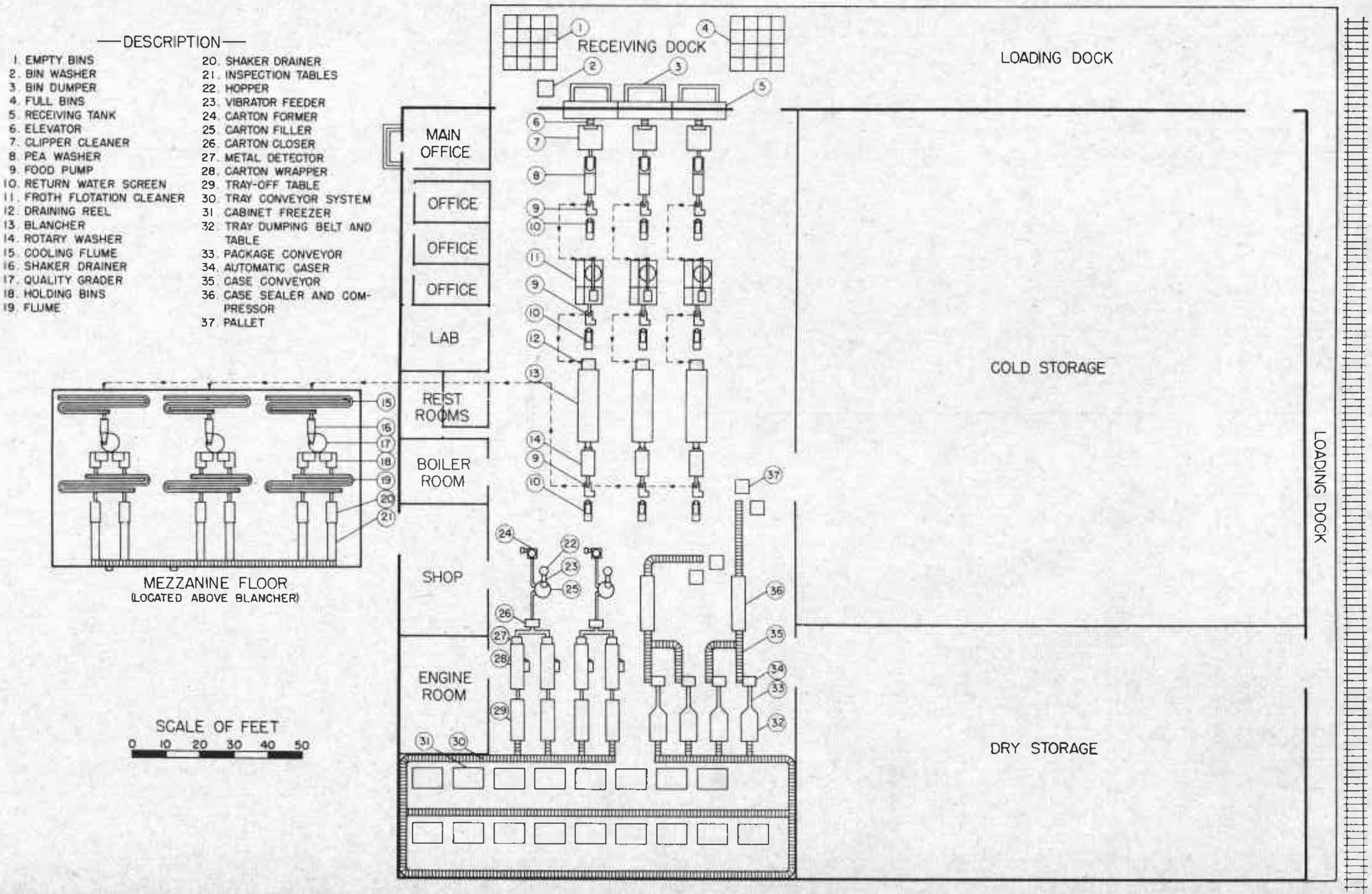
Item of equipment	Estimated replacement cost[2]	Years useful life	Number required for different hourly rates of output — Pounds clean peas per hour: 10,000	20,000	30,000
Preparation (Cont.)	$				
Tray filling table	100.00	15	2	4	6
Conveyor, gravity roll 2"x14" rollers on 4" centers coupl w/stand 100 ft. sections	650.00	15	2	4	6
Tray dumping belt 5'x24" conveyor belt and steel frame	400.00	15	2	4	5
Tray rack, wood frame holds 40 empty trays	25.00	10	7	14	20
Package conveyor, 10' live belt, ⅓ HP motor	400.00	15	2	4	5
Case forming table	50.00	15	2	4	5
Automatic caser	6,300.00	10	2	4	5
Case conveyor, 25' live belt	1,200.00	15	1	2	3
Sealer and 20' compressor	5,800.00	10	1	2	3
Case conveyor, 25' live belt	1,200.00	15	1	2	3
Forklift truck (3000 lb. cap.)	5,500.00	10	1	1	2
Pallet (40"x48")	3.00	10	667[7]	1,333[7]	2,000[7]
Freezing					
Cabinet, 20 station	7,600.00	15	9	17	25
Hydraulic pump, 30 gal. w/2 HP motor	750.00	15	2	4	5
Refrigeration cycle, compl., includes compressors, condensers, receivers, pipe, and refrigerant. Required tons of refrigeration:					
165	112,200.00	15	1	–	–
330	211,200.00	15	–	1	–
495	297,000.00	15	–	–	1
Electrical installation, compl. includes electrical requirements from main line into plant. Required HP:					
371	8,013.60	15	1	–	–
743	11,888.00	15	–	1	–
1,114	13,368.00	15	–	–	1

[1] See footnote one on page 73.
[2] See footnote two on page 73.
[7] See footnote seven on page 73.

Appendix Figure 1. Process flow diagram for pea-freezing plants.



Appendix Figure 2. Pea-freezing plant layout—20,000 pounds capacity per hour.



In estimating costs for this operation the following assumptions have been made:

1. The permanent station method of vining is used in all areas. Because of the concentration of large acreages of peas in Eastern Oregon and Western Washington, vining stations are assumed to have a maximum of 16 viners as compared to 8 in the other regions.
2. Distances one way for all areas:
   Field to vining station—5 miles.
   Vining station to plant—10 miles.
3. A pea-vine ratio of 20% for all areas.
4. Lengths of operating season or hours of use per year for vining equipment and facilities are as follows:

AREA	TOTAL USE	USE FOR PEAS
	Hours	*Hours*
Eastern Oregon	900	900
Western Washington	800	800
Minnesota	500	400
New York	500	400
Maine	600	600
Eastern Seashore	900	500

5. Any value of vines to the grower or processor is excluded.

Estimated costs of vining based upon conditions indicated above are shown for each region in Appendix Figure 3 and Appendix Table 15. These costs were derived from the labor and equipment standards and costs developed earlier in Appendix Tables 12 through 14 and from hauling charges shown in Appendix Table 16.

Stage 2—Preparation

The preparation stage of processing includes all operations after clipper cleaning through hand sorting and inspection. These include washing, froth cleaning, blanching, quality grading, and inspection.

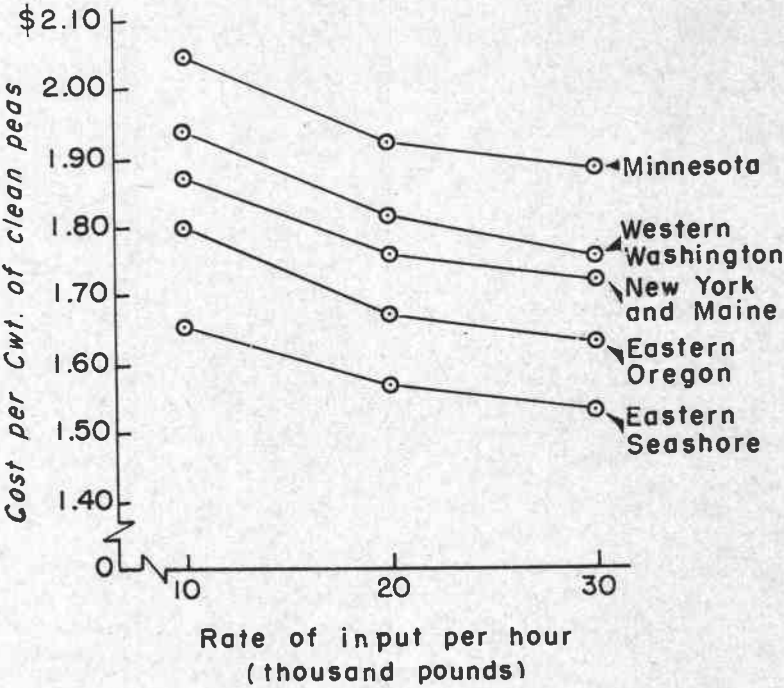
The following assumptions were made in estimating preparation costs:

1. Regional differences in quality have no effect on cleaning, grading, and inspection requirements.

2. Total hours of use per year for preparation equipment are as follows:

AREA	TOTAL USE	USE FOR PEAS
	Hours	*Hours*
Eastern Oregon	900	900
Western Washington	800	800
Minnesota	500	400
New York	500	400
Maine	600	600
Eastern Seashore	900	500

Appendix Figure 3. Comparative costs for vining peas in the major producing areas, 1959.[1]



[1] Due to the limited number of firms in New York and Maine, vining costs are shown as an average for these two areas.

Appendix Table 15. Estimated costs of vining peas as related to size of operation for major producing areas, 1959[1]

Input of clean peas per hour	Costs per hundredweight[2]			
	Labor[3]	Hauling vines and shelled peas	Equipment and facilities	Total costs[4]
Pounds	$	$	$	$
		EASTERN OREGON		
10,000	.63	.72	.46	1.80
20,000	.54	.72	.42	1.68
30,000	.51	.72	.40	1.62
		WESTERN WASHINGTON		
10,000	.72	.72	.50	1.94
20,000	.65	.72	.45	1.81
30,000	.60	.72	.43	1.75
		MINNESOTA		
10,000	.58	.67	.79	2.04
20,000	.52	.67	.73	1.92
30,000	.50	.67	.71	1.88
		NEW YORK AND MAINE		
10,000	.52	.64	.71	1.67
20,000	.46	.64	.65	1.76
30,000	.44	.64	.63	1.72
		EASTERN SEASHORE		
10,000	.52	.64	.49	1.65
20,000	.48	.64	.45	1.57
30,000	.45	.64	.43	1.52

[1] Due to the limited number of firms in New York and Maine, vining costs are shown as an average for these two areas.

[2] Costs are rounded to the nearest cent.

[3] Excludes labor for hauling vines and peas.

[4] Discrepancies in totals result from rounding.

Appendix Table 16. Estimated custom rates for hauling vines and peas in major producing areas, 1959[1]

Region	Vine trucks	Bin trucks
	Dollars per hour[2]	Dollars per ton[3]
Eastern Oregon	$5.08	$4.16
Western Washington	5.08	4.16
Minnesota	4.76	3.90
New York and Maine	4.56	3.74
Eastern Seashore	4.56	3.74

[1] Rates shown include driver and all truck expenses. Distances were assumed as follows for all areas:

a. Field to vining station—5 miles.

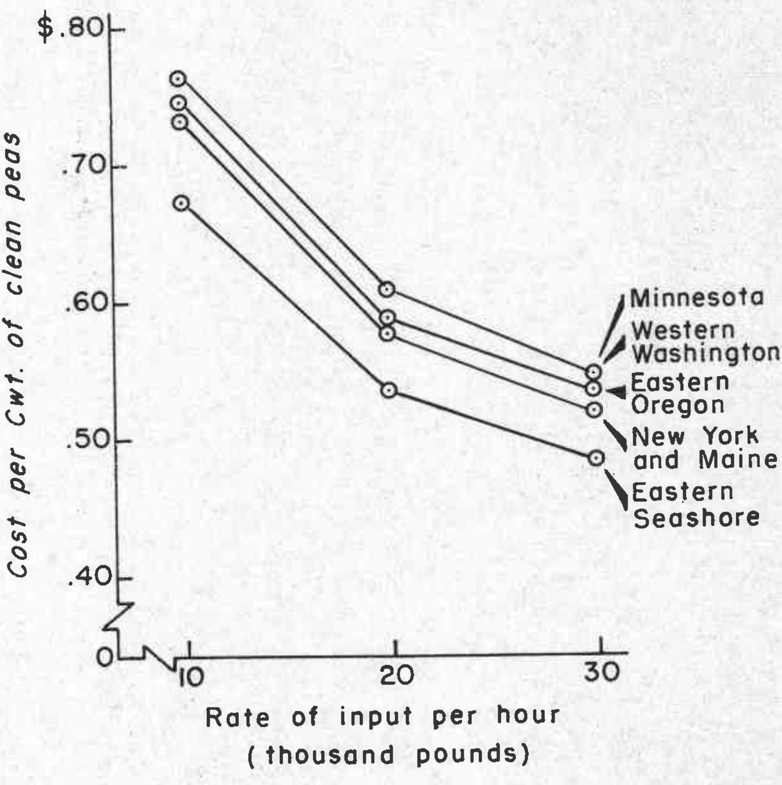
b. Vining station to plant—10 miles.

[2] For hauling vines from field to vining station.

[3] For loading and hauling bins of shelled peas from vining station to plant and returning empty bins. Rates have been converted to a clean pea basis.

Eastern Seashore has the lowest preparation costs because of a combination of relatively low wage rates and a long season for the use of preparation equipment (Appendix Figure 4 and Appendix Table 17). High wage rates make total costs in the Northwest comparatively high, even though equipment is used for a longer period each year than in most areas.

Appendix Figure 4. Comparative costs of preparing peas for freezing in major producing areas, 1959.[1]



[1] Due to the limited number of firms in New York and Maine, preparation costs are shown as an average for these two areas.

Appendix Table 17. **Estimated costs of preparation of peas for freezing as related to size of operation for major producing areas, 1959**[1]

Input of clean peas per hour	Costs per hundredweight[2]		
	Labor	Equipment[3]	Total costs
Pounds	$	$	$
		EASTERN OREGON	
10,000	.32	.42	.74
20,000	.26	.32	.59
30,000	.24	.29	.53
		WESTERN WASHINGTON	
10,000	.32	.44	.76
20,000	.27	.33	.61
30,000	.25	.30	.55
		MINNESOTA	
10,000	.28	.48	.76
20,000	.24	.37	.60
30,000	.21	.33	.54
		NEW YORK AND MAINE	
10,000	.25	.49	.73
20,000	.21	.37	.58
30,000	.19	.33	.52
		EASTERN SEASHORE	
10,000	.26	.42	.67
20,000	.22	.32	.54
30,000	.19	.29	.48

[1] Due to the limited number of firms in New York and Maine, preparation costs are shown as an average for these two areas.

[2] Discrepancies in totals result from rounding.

[3] Includes cost of supplies such as orvis oil and salt.

Stage 3—Packaging and freezing

This stage extends from the last hand grading or inspection operation through packaging, freezing, and casing, and ends with the frozen product in storage. Costs of this stage are affected by methods used, rate of output per hour, and length of season. The combination of container sizes into which the product is packed and the amount of flexibility with respect to choice among container sizes also have important effects on costs. The effects of these variables on cost will not be discussed in this report but are treated in earlier publications (11) (37).

Assumptions upon which packaging and freezing costs are based are:

1. Only the costs of packaging and freezing 10-ounce packages are considered.
2. No excess packaging and casing capacity exists. The capacity of packaging and casing equipment equals plant capacity and there is no flexibility with respect to container size.
3. Number of hours of operation per year for packaging and freezing equipment is as follows:

AREA	TOTAL USE	USE FOR PEAS
	Hours	*Hours*
Eastern Oregon	1,000	900
Western Washington	1,000	800
Minnesota	1,200	400
New York	1,200	400
Maine	1,200	600
Eastern Seashore	1,500	500

Under the conditions assumed above, the pea-freezing areas of the Pacific Northwest had the highest costs and the Eastern Seashore the lowest (Appendix Figure 5 and Appendix Table 18). These costs are based upon labor and equipment costs cited earlier plus appropriate cost items shown in Appendix Tables 19, 20, and 21.

Stage 4—Shipping and storage

This stage covers the cost of operations involved in refrigerating the product in storage, moving it out of storage, and loading it into rail cars or trucks. Costs are based upon plant record studies made in the Pacific Northwest and have been applied to the other regions by weighting them according to regional differences in packaging and freezing costs (Appendix Table 22). It has been assumed that the movement out of storage is at the same rate and volume for all regions.

Stage 5—Building costs

Building costs are based upon (1) estimated floor space requirements for efficiently organized plants of 10,000, 20,000, and 30,000 pounds per hour input capacities; (2) engineering estimates of quantities of building materials and construction labor required for buildings of selected sizes and specifications; and (3) current regional wage rates and prices for materials.

Appendix Table 18. Estimated costs of packaging and freezing peas as related to size of operation for major producing areas, 1959[1]

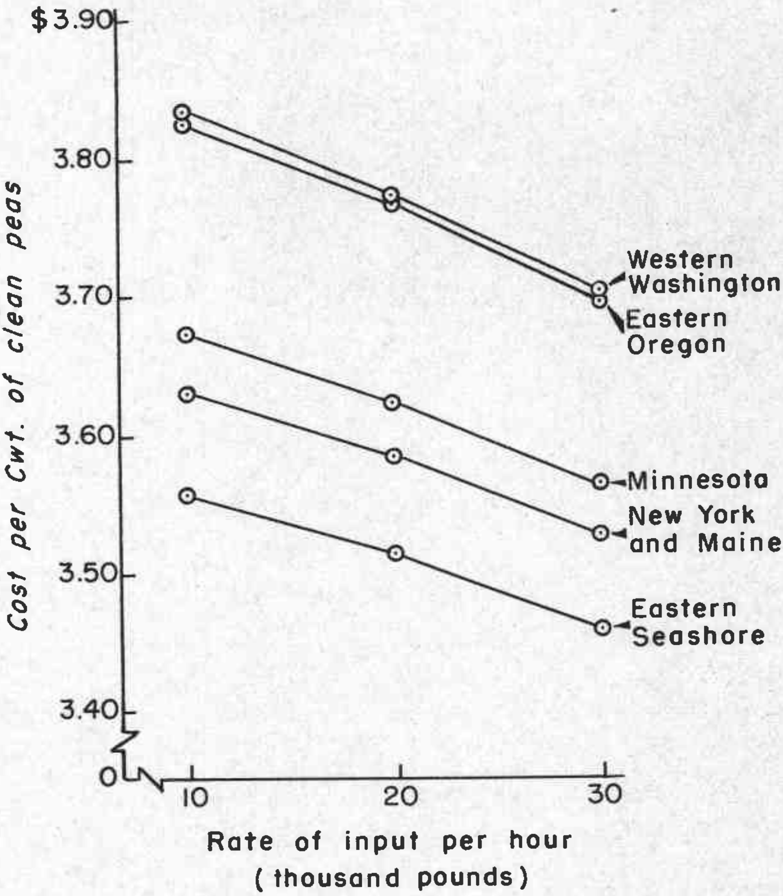
Input of clean peas per hour	Cost per hundredweight[2] Packaging and freezing labor	Packaging and freezing equipment	Packaging materials	Total costs[3]
Pounds	$	$	$	$
		EASTERN OREGON		
10,000	.49	.72	2.61	3.83
20,000	.47	.68	2.61	3.77
30,000	.43	.65	2.61	3.70
		WESTERN WASHINGTON		
10,000	.50	.72	2.61	3.83
20,000	.48	.68	2.61	3.77
30,000	.44	.65	2.61	3.70
		MINNESOTA		
10,000	.43	.63	2.61	3.67
20,000	.41	.60	2.61	3.62
30,000	.37	.58	2.61	3.56
		NEW YORK AND MAINE		
10,000	.38	.63	2.62	3.63
20,000	.37	.60	2.62	3.58
30,000	.33	.57	2.62	3.53
		EASTERN SEASHORE		
10,000	.39	.55	2.62	3.56
20,000	.38	.52	2.62	3.51
30,000	.34	.50	2.62	3.46

[1] Due to the limited number of firms in New York and Maine, packaging and freezing costs are shown as an average for these two areas.
[2] Costs are rounded to the nearest cent.
[3] Discrepancies in totals result from rounding.

Appendix Table 19. Estimated electrical power and water charges for processing and freezing peas in major producing areas, 1959

Producing region	Electrical power charge	Water charges
	Cents per kilowatt hour	*Cents per thous. gallons*
Eastern Oregon	.87	6.7
Western Washington	.87	6.7
Minnesota	1.65	8.2
New York and Maine	1.65	8.2
Eastern Seashore	1.25	7.4

Appendix Figure 5. Comparative costs of packaging and freezing peas in major producing areas, 1959.[1]



[1] Due to the limited number of firms in New York and Maine, packaging and freezing costs are shown as an average for these two areas.

Appendix Table 20. Estimated fuel consumption rates for equipment required for processing frozen peas in major producing areas, 1959[1]

Item of equipment	Gasoline	Diesel	Oil	Grease
	Gallons per hour	*Gallons per hour*	*Quarts per 100 hours*	*Lbs. per 100 hours*
Swather and wheel tractor	2	----	5	8
Pick-up truck	.33	----	3	2
Crawler tractor	----	3.5	8	8
Fork lift truck (3,000 lbs.)	1.1	----	5	4

[1] Fuel prices used in converting physical requirements to costs are as follows:
Gasoline............22¢ per gallon—all areas.
Oil ....40¢ per quart—all areas.
Grease..............25¢ per pound—all areas.

Floor space requirements for efficiently organized plants of selected sizes were derived from observations of existing plants, dimensions of required equipment and working space, and published data. These include space allowances for receiving dock, processing, freezing, cold storage, dry storage, office, shop, laboratory, boiler room, refrigeration engine room, car loading dock, and truck loading dock (Appendix Figure 2 and Appendix Table 23).

Buildings upon which costs are based are constructed with concrete floors, concrete side walls, and asphalt roofs. Ceiling height (from floor to underside of trusses) is 16 feet where there is no mezzanine and 27 feet where the mezzanine is located. Mezzanine is 16 feet above the main floor. Loading and receiving docks are of concrete construction, 4 feet high. Costs include primary plumbing lines, primary water lines, and main electrical panels and lighting. Costs of plumbing and electrical installations assignable to specified items of equipment have been included earlier under equipment costs. Costs, however, do include such improvements as plumbing, lighting, heating, etc. for offices, rest rooms, and the laboratory.

In the manner described above, replacement costs for buildings of selected sizes and specifications were developed for the Northwest with the aid of consulting engineers and contractors. These costs then were adjusted to reflect costs in the other pea-freezing areas through the use of regional building cost indices computed in Appendix Table 24 and then converted to annual costs (Appendix Table 25). These are portrayed graphically in Appendix Figure 6.

Appendix Table 21. Estimated costs of packaging materials for freezing peas in 24 10-ounce cases in major producing areas, 1959[1]

Item of packaging materials	Production and processing area					
	Eastern Oregon	Western Washington	Minnesota	New York	Maine	Eastern Seashore
	Cost per hundredweight peas					
Carton 10-ounce .015 solid bleached sulphite waxed end opening, plain, no printing, 5"x4"x1¼"	$1.516	$1.516	$1.516	$1.516	$1.516	$1.516
Wrapper 10-ounce printed 5 color, 32 to 43½ pound bleached sulphite waxed for 5"x4"x1¼" carton, 12"x7⅝"	.654	.654	.639	.639	.639	.639
Case of 24 10-ounce 175 B kraft, glued, printed on 4 panels one color 15¾"x8⅜"x 5½"	.443	.443	.458	.464	.464	.464
Total cost	$2.613	$2.613	$2.613	$2.619	$2.619	$2.619

[1] Assumes the plate method of freezing and includes the following allowances for shrinkage:
Cartons—3%.
Wrappers—4%.
Cases—1%.

Appendix Table 22. Estimated cost for shipping and storage of frozen peas in major producing areas, 1959

Region	Estimated cost per hundredweight for freezing and packaging[1]	Index[2]	Estimated cost per hundredweight for shipping and storage[3]
	$		$
Eastern Oregon	3.77	100.0	.95
Western Washington	3.77	100.0	.95
Minnesota	3.62	96.0	.91
New York and Maine	3.58	95.0	.90
Eastern Seashore	3.51	93.1	.88

[1] Assumes an output rate of 20,000 pounds per hour.

[2] Costs in Eastern Oregon and Western Washington equal 100.

[3] Based on accounting record data for the Northwest and adjusted by index of packaging and freezing costs in each area.

Appendix Table 23. Estimated building space requirements for frozen pea plants of selected hourly rates of output, 1959

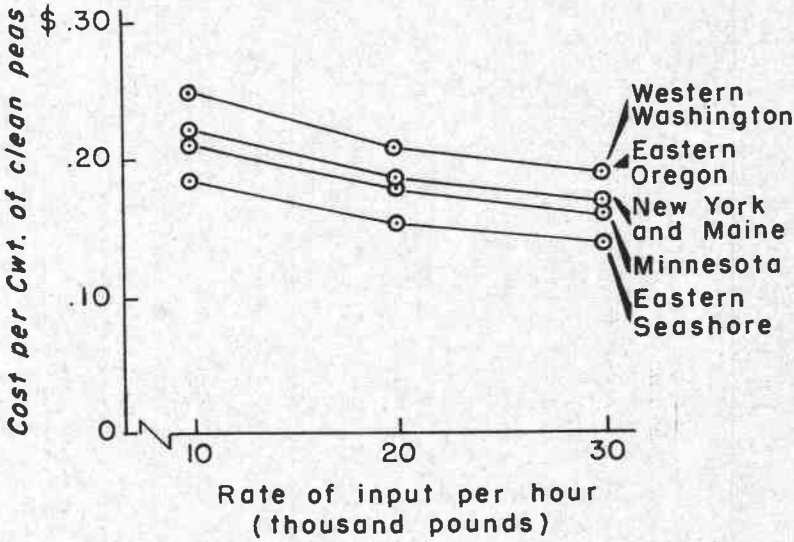
Item	Space requirements for plants of different sizes		
	Pounds of clean peas per hour		
	10,000	20,000	30,000
	Square feet		
Main processing floor	12,426	21,218	30,476
Mezzanine	3,141	4,711	6,282
Cold storage	11,250	22,500	33,750
Dry storage	5,550	11,100	16,650
Office	1,200	1,500	1,800
Shop	800	1,000	1,200
Laboratory	400	500	600
Boiler room	400	500	600
Rest rooms	300	500	700
Engine room for refrigeration	600	900	1,200
Total excluding docks	36,067	64,429	93,258
Receiving dock	1,446	2,718	3,458
Car loading dock	2,286	2,286	2,286
Truck loading dock	2,250	4,500	6,750
Total including docks	42,049	73,933	105,752

Appendix Table 24. Regional building construction cost indices applicable to pea-freezing plants, 1959

Region	Metropolitan areas used as basis of regional building cost indices[1]	Index[1]	Regional building cost as percent of northwest building costs
Eastern Oregon	Seattle area	336.3	100
Western Washington	Seattle area	336.3	100
Minnesota	Minneapolis area	314.2	93.4
New York and Maine	Cleveland area Boston area	337.4 319.6	97.7
Eastern Seashore	Baltimore area Philadelphia area	294.1 323.1	91.8

[1] January 1959 cost index for commercial and factory buildings of concrete construction for major metropolitan areas of United States (9, p. 88). U. S. average—1926–29 = 100.

Appendix Figure 6. Estimated annual building costs for pea-freezing plants in major producing areas, 1959.[1]



[1] Due to the limited number of firms in New York and Maine, building costs are shown as an average for these two areas.

Appendix Table 25. Floor space requirements, replacement, and annual costs of processing plant buildings, for a plant of a given size, in major producing areas, 1959[1]

		Processing area							
		Eastern Ore. and Western Wash.		Minnesota		New York and Maine		Eastern Seashore	
Item	Space required	Replacement cost	Annual cost[2]	Replacement cost	Annual cost[2]	Replacement cost	Annual cost[2]	Replacement cost	Annual cost[2]
	Square feet	$	$	$	$	$	$	$	$
Main processing floor	21,218	141,099.70	12,557.87	131,787.12	11,729.05	137,854.41	12,269.04	129,529.52	11,528.13
Mezzanine	4,711	44,754.50	3,983.15	41,800.70	3,720.26	43,725.15	3,891.54	41,084.63	3,656.53
Cold storage	22,500	155,025.00	13,797.22	144,793.35	12,886.61	151,459.43	13,479.89	142,312.95	12,665.85
Dry storage	11,100	63,270.00	5,631.03	59,094.18	5,259.38	61,814.79	5,501.52	58,081.86	5,169.29
Office	1,500	12,825.00	1,141.42	11,978.55	1,066.09	12,530.03	1,115.17	11,773.35	1,047.83
Shop	1,000	5,700.00	507.30	5,323.80	473.82	5,568.90	495.63	5,232.60	465.70
Laboratory	500	4,750.00	422.75	4,436.50	394.85	4,640.75	413.03	4,360.50	388.08
Boiler room	500	2,375.00	211.38	2,218.25	197.42	2,320.38	206.51	2,180.25	194.04
Rest rooms	500	4,750.00	422.75	4,436.50	394.85	4,640.75	413.02	4,360.50	388.08
Engine room for refrigeration	900	4,275.00	380.48	3,992.85	355.36	4,176.68	371.72	3,942.45	349.28
Receiving dock	2,718	7,746.30	689.42	7,235.04	643.92	7,568.14	673.56	7,111.10	632.89
Car loading dock	2,286	6,515.10	579.84	6,085.10	541.57	6,365.25	566.51	5,980.86	532.30
Truck loading dock	4,500	12,825.00	1,141.42	11,978.55	1,066.09	12,530.03	1,115.17	11,773.35	1,047.83
Total cost		465,910.60	41,466.03	435,160.49	38,729.27	455,194.69	40,512.31	427,705.92	38,065.83

[1] Assumes a plant with capacity output rate of 20,000 pounds per hour.

[2] Annual costs based upon a percentage of building replacement costs as follows: depreciation—2.5%, repairs—1.8%, insurance—0.6%, taxes—1%, and interest—3% (interest at 3% equal to approximately 5% of undepreciated balance). Building costs per unit, of course, depend upon total season's output.

Stages 6, 7, and 8—Administrative costs

These stages represent operations associated with plant administration and management for which costs have not been assigned to any particular operation.

Stage 6 includes costs of supervisory and management personnel above the level of foreman, overhead such as water, heat, and lights not assigned to particular items of equipment or jobs, and office costs. This stage includes also an allowance for interest on operating capital as distinguished from interest on investment already included in annual equipment and building costs.

Stage 7 accounts for all costs of operation of the field office and field force not paid by the grower in the form of charges for services or materials provided by the processor.

Stage 8 includes a brokerage fee for selling the finished product as well as an allowance for time, telephone service, and travel expenses of sales personnel.

Estimates for each of the administrative cost stages were obtained from accounting record data and interviews with management in a number of plants. Because of the confidential nature of the data, they have been included in total processing costs expressed in terms of index numbers.

Estimated Total Processing Costs

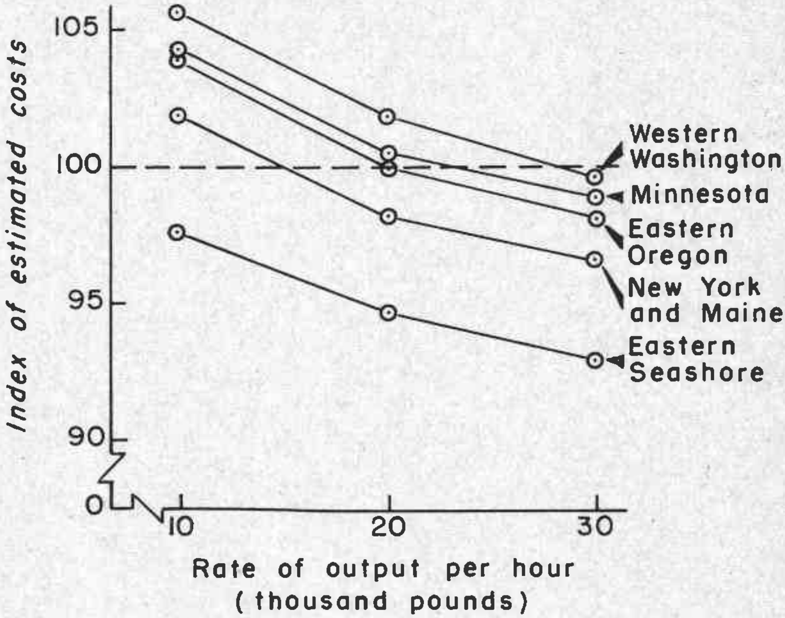
Total processing costs are highest for Western Washington, while Eastern Oregon falls toward the middle of the group (Appendix Figure 7).[3] Eastern Seashore has the lowest costs because of the relatively low wage rates and a long season's use for much of the equipment.

Relative Total Costs of Production and Processing

When raw product and processing costs are combined, Maine, closely followed by Eastern Oregon, had the lowest "at plant" costs and the Eastern Seashore the highest (Appendix Table 26). These costs were obtained by adding the processing costs from Appendix Figure 7 to the raw product costs cited in Appendix Table 1. Processing costs are based on plants with an output rate per hour of 30,000 pounds for the two Pacific Northwest areas and 20,000 pounds for all other areas. The lower output level assumes that the smaller, more scattered acreages of peas and the product mix of existing plants in New York, Maine, Minnesota, and the Eastern Seashore will normally not support an output rate in excess of 20,000 pounds per hour.

[3] All regional costs have been adjusted to a 90% recovery rate (i.e., 10% by weight of product received is lost during processing).

Appendix Figure 7. Comparative total costs of processing and freezing peas in major producing areas, 1959.[1]



[1] Plant costs for a plant in eastern Oregon with a rate of output of 20,000 pounds per hour = 100. Costs are based on 10-ounce operations.

Appendix Table 26. Index of estimated total "at plant" costs for frozen peas in major producing areas, 1959[1]

Area	Index of total raw product and processing cost[2]
Eastern Oregon	100.0
Western Washington	105.3
New York	108.1
Minnesota	108.8
Maine	99.5
Eastern Seashore	121.6

[1] The vining costs previously included under production costs have been deleted since they also were included in total processing costs.
[2] Eastern Oregon costs = 100.

Appendix Table 27. Rail rates for transporting frozen peas from major producing regions to selected consuming regions, 1959[1]

To—Consuming regions		From—Major pea-freezing regions					
		Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
Region	Destination point	Walla Walla, Washington	Seattle, Washington	Mankato, Minnesota[2]	Rochester, New York	Bangor, Maine	Wilmington, Delaware
		Dollars per hundredweight[3]					
1	Boston, Mass.	2.57	2.57	2.50	1.48[c]	1.43[c]	1.22[c]
2	Scranton, Pa.	2.52	2.52	2.56[c]	1.27[c]	1.95[c]	.95[c]
3	Detroit, Michigan	2.38	2.38	1.92[c]	1.46[c]	2.39[c]	1.67[c]
4	Chicago, Ill.	2.32	2.32	1.58[c]	1.92[c]	2.52	1.89[c]
5	Minneapolis, Minn.	2.16	2.16	......	2.39[c]	2.55	2.58
6	Omaha, Nebraska	2.16	2.16	1.50[c]	2.61[c]	2.55	2.57
7	Montgomery, Ala.	2.43	2.43	2.38	2.72[c]	3.22[c]	2.55[c]
8	Dallas, Texas	2.32	2.32	2.23	2.55	3.91[c]	2.64
9	Los Angeles, Calif.	1.41[a]	1.41[a]	2.31	2.66	2.69	2.71
10	Portland, Oregon	.84[d]	.86[b]	2.21	2.66	2.69	2.69

[1] Carload rates (60,000 pound minimum gross weight except as noted). Rates include refrigeration charges.
[a] 50,000 pound minimum
[b] 40,000 pound minimum
[c] 36,000 pound minimum
[d] 34,000 pound minimum
[2] Rail rates from Region 3 are quoted from Minneapolis because rates from Mankato were not available.
[3] Gross rates have been converted to net weight of frozen peas as follows: There are 15 pounds of frozen peas in a 24-10-ounce case. Total weight of case including packaging materials is 17 pounds. Conversion ratio is 1.13333.

Appendix Table 28. Truck rates for transporting frozen peas from major producing regions to selected consuming regions, 1959[1]

To—Consuming regions		From—Major pea-freezing regions					
		Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
Region	Destination point	Walla Walla, Washington	Seattle, Washington	Mankato, Minnesota	Rochester, New York	Bangor, Maine	Wilmington, Delaware
		Dollars per hundredweight[2]					
1	Boston, Mass.	6.32	6.32	3.31	1.53	2.29	1.69
2	Scranton, Pa.	6.32	6.32	2.97	1.11	2.10	1.47
3	Detroit, Mich.	2.95	2.95	1.90	1.14	2.50	1.84
4	Chicago, Ill.	2.55	2.55	1.52	1.36	5.05	1.93
5	Minneapolis, Minn.	2.45	2.45	.67	2.61	3.17	2.18
6	Omaha, Nebraska	2.15	2.15	1.25	3.13	2.29	1.42
7	Montgomery, Ala.	5.52	5.52	1.67	2.06	2.74	1.87
8	Dallas, Texas	5.27	5.27	1.87	2.96	3.58	2.88
9	Los Angeles, Calif.	1.73	1.65	5.00	6.32	7.60	6.32
10	Portland, Oregon	.62	.62	4.74	6.32	7.60	6.32

[1] Truckload rates include refrigeration charges.

[2] Gross rates have been converted to net weight of frozen peas as follows: There are 15 pounds of frozen peas in a 24 - 10-ounce case. Total weight of case including packaging materials is 17 pounds. Conversion ratio is 1.13333.

Appendix Table 29. Per capita consumption of peas—fresh, canned, and frozen—United States, 1937-59[1]

Year	(Fresh equivalent basis—in pod) Fresh	Canned	Frozen
	Pounds	*Pounds*	*Pounds*
1959	.30	8.25	4.52
1958	.30	7.92	4.62
1957	.30	8.05	4.45
1956	.30	8.17	4.21
1955	.40	8.07	3.78
1954	.40	8.26	3.92
1953	.40	8.33	3.52
1952	.50	8.63	3.35
1951	.60	9.00	2.85
1950	.70	9.16	2.43
1949	.80	8.96	2.10
1948	.90	9.78	2.55
1947	1.10	9.84	2.29
1946	1.40	12.82	1.69
1945	1.60	12.06	1.76
1944	1.70	8.89	1.59
1943	1.60	9.86	.75
1942	1.70	10.73	1.16
1941	2.10	10.38	.89
1940	2.10	9.26	.58
1939	2.30	8.39	.62
1938	2.10	8.18	.42
1937	2.30	7.76	.41

[1] Canned and frozen consumption has been converted to fresh equivalent. *Source:* (79, p. 31).

Appendix Table 30. Per capita consumption of frozen vegetables, United States 1937-59[1]

Year	Asparagus	Snap beans	Lima beans	Carrots	Peas	Peas and carrots	Pumpkin and squash	Broccoli	Brussels sprouts	Spinach	Cauliflower	Corn, cut basis	Succotash	Rhubarb	Potato products	Other	Total[2]
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1937	0.03	0.05	0.11	[3]	0.15	[3]	[3]	0.01	[3]	0.02	[3]	0.03	[4]	[4]	[4]	[3]	0.40
1938	.05	.05	.09	[3]	.15	[3]	0.01	.02	[3]	.02	[3]	.02	[4]	[4]	[4]	[3]	.41
1939	.03	.04	.11	[3]	.22	0.01	.01	.02	[3]	.01	[3]	.04	[4]	[4]	[4]	0.01	.50
1940	.05	.04	.13	[3]	.21	[3]	.01	.01	0.01	.04	0.01	.05	[4]	[4]	[4]	.01	.57
1941	.05	.07	.11	0.01	.32	[3]	.01	.03	.01	.01	[3]	.04	[4]	[4]	[4]	.01	.67
1942	.04	.10	.24	.01	.41	.01	.02	.03	.02	.13	.01	.07	[4]	[4]	[4]	.01	1.10
1943	.06	.05	.14	[3]	.27	.01	.03	.03	.02	.11	[3]	.02	[4]	[3]	[4]	[3]	.74
1944	.11	.16	.17	.03	.56	.02	.07	.03	.05	.18	.04	.11	[3]	0.04	[4]	.06	1.63
1945	.14	.20	.17	.02	.62	.02	.08	.08	.05	.26	.04	.13	0.01	.04	[4]	.04	1.90
1946	.13	.20	.27	.04	.60	.04	.03	.12	.07	.20	.07	.15	.01	.05	[4]	.06	2.04
1947	.11	.26	.38	.07	.81	.04	.06	.11	.04	.22	.04	.25	.01	.08	0.01	.09	2.58
1948	.14	.29	.38	.05	.91	.07	.05	.17	.07	.31	.09	.23	.05	.02	.05	.10	2.98
1949	.13	.28	.49	.10	.75	.04	.03	.21	.12	.29	.10	.22	.05	.02	.07	.11	3.01
1950	.12	.35	.51	.08	.86	.06	.06	.22	.09	.38	.09	.21	.05	.03	.12	.15	3.38
1951	.13	.45	.55	.09	1.02	.08	.06	.31	.13	.50	.13	.31	.06	.04	.23	.22	4.31
1952	.15	.53	.71	.11	1.16	.10	.06	.44	.14	.50	.18	.39	.08	.04	.36	.33	5.28
1953	.16	.57	.73	.13	1.25	.09	.07	.43	.18	.51	.16	.45	.06	.03	.31	.30	5.43
1954	.17	.64	.66	.17	1.40	.11	.09	.47	.16	.51	.17	.43	.07	.05	.44	.36	5.90
1955	.16	.66	.72	.21	1.34	.10	.09	.54	.17	.57	.19	.51	.06	.04	.74	.54	6.64
1956	.17	.72	.75	.15	1.50	.08	.10	.54	.20	.56	.19	.66	.03	.02	1.20	.39	7.26
1957	.16	.73	.73	.27	1.58	.12	.13	.50	.19	.53	.15	.59	.07	.04	1.22	.48	7.49
1958	.15	.79	.72	.24	1.64	.11	.09	.56	.17	.55	.17	.70	.06	.03	1.44	.66	8.08
1959[5]	.19	.80	.71	.31	1.61	.14	.10	.59	.20	.62	.19	.68	.05	.02	2.07	.61	8.89

[1] Civilian consumption only, beginning 1941.
[2] Computed from unrounded data.
[3] Less than 0.005 pound.
[4] Included with "other."
[5] Preliminary.
Source: (79, p. 33).

Appendix Table 31. **Frozen pea disappearance by crop year, United States, 1948-59**

Crop year[1]	Carry-in[2]	Pack[3]	Carry-over[2]	Net disappearance
	Thousand pounds of packed peas			
1948-49	53,721	118,977	46,739	125,959
1949-50	46,739	113,273	35,793	124,219
1950-51	35,793	152,275	44,841	143,227
1951-52	44,841	195,541	65,236	175,146
1952-53	65,236	203,726	65,950	203,012
1953-54	65,950	222,543	60,776	227,717
1954-55	60,776	206,854	42,112	225,518
1955-56	42,112	231,216	49,289	224,039
1956-57	49,289	359,661	118,268	290,682
1957-58	118,268	295,823	116,853	297,238
1958-59	116,853	251,934	84,513	284,274
1959-60	84,513	304,634	92,605[4]	296,542

[1] Crop year beginning June 1 and ending May 31.
[2] Carry-in on June 1—carry-out on May 31 of crop year. *Source:* (74).
[3] *Source:* National Association of Frozen Food Packers (58).
[4] Estimated.

Appendix Table 32. **Per capita disappearance of frozen peas, United States, 1948-59**

Crop year[1]	Net disappearance of frozen peas[2]	United States population[3]	Per capita disappearance
	Thous. lbs. frozen peas	*Thous. people*	*Pounds*
1948-49	125,959	146,093	.862
1949-50	124,219	148,665	.836
1950-51	143,227	151,234	.947
1951-52	175,146	153,384	1.142
1952-53	203,012	155,761	1.303
1953-54	227,717	158,313	1.438
1954-55	225,518	161,191	1.399
1955-56	224,039	164,303	1.364
1956-57	290,682	167,259	1.738
1957-58	297,238	170,293	1.745
1958-59	284,274	173,232	1.641
1959-60	296,542	176,365	1.681

[1] Crop-year beginning June 1 and ending May 31.
[2] See Appendix Table 31 for source and method of calculation.
[3] As reported on July 1 of crop year. *Source:* (81).

Appendix Table 33. Average retail price of frozen peas in 10-ounce packages by region for crop years 1950-51 through 1959-60

Crop year	U. S. average retail price	Consuming region									
		1	2	3	4	5	6	7	8	9	10
	Cents per 10-oz. pkg.	*Cents per 10-oz. pkg.*[1]									
1950-51	20.8	19.8	20.9	21.6	19.9	20.5	20.1	22.4	21.9	20.9	21.3
1951-52	20.3	19.4	20.6	20.6	19.7	20.0	20.1	21.5	20.7	20.2	20.6
1952-53	19.5	18.0	19.8	20.0	18.4	19.6	20.1	20.3	18.9	19.4	20.2
1953-54	19.2	17.4	18.7	18.7	17.9	19.0	19.1	20.2	18.5	19.1	19.0
1954-55	19.4	18.1	19.4	19.6	18.9	20.0	19.1	19.8	18.7	19.3	18.4
1955-56	20.9	20.3	20.9	21.5	19.9	20.6	20.6	21.4	20.2	21.4	20.5
1956-57	20.5	20.0	20.3	21.1	19.5	20.6	20.5	20.6	20.6	20.9	19.7
1957-58	19.6	19.4	19.4	20.2	19.0	19.4	19.3	19.5	19.6	20.2	18.9
1958-59	19.8	19.3	19.8	20.6	19.0	19.4	19.6	19.6	19.5	20.2	19.3
1959-60	19.1	19.5	19.7	20.5	18.5	19.7	19.9	19.6	19.2	20.4	19.4
Average all years	19.91	19.12	19.95	20.44	19.07	19.88	19.84	20.49	19.78	20.20	19.73

[1] All prices are expressed in terms of 1959 price level. *Source:* (82).

Appendix Table 34. Five-year moving-average yield per acre of peas for freezing, United States, 1947-59

Crop year[1]	United States average yield/acre[2]	Five-year moving total	Five-year moving average
	Pounds	*Pounds*	*Pounds*
1943-44	2,048		
1944-45	1,677		
1945-46	1,966		
1946-47	2,024		
1947-48	1,778	9,493	1,899
1948-49	2,000	9,445	1,889
1949-50	1,774	9,542	1,908
1950-51	1,922	9,498	1,900
1951-52	2,040	9,514	1,903
1952-53	2,156	9,892	1,978
1953-54	2,326	10,218	2,044
1954-55	1,968	10,412	2,082
1955-56	2,065	10,555	2,111
1956-57	2,701	11,216	2,243
1957-58	2,530	11,590	2,318
1958-59	2,644	11,908	2,382
1959-60	2,853	12,793	2,559

[1] Frozen pea crop year beginning June 1 and ending May 31.
[2] *Source:* (80).

Appendix Table 35. Average grower price received per acre of peas for freezing, United States, 1947-59

Crop year[1]	United States average grower price received per ton of peas for freezing[2]	United States five-year moving-average yield per acre[3]	United States average grower price received per acre of peas for freezing[4]
	Dollars	*Tons*	*Dollars*
1947-48	98.81	.9495	93.82
1948-49	97.10	.9445	91.71
1949-50	94.04	.9540	89.71
1950-51	87.50	.9500	83.13
1951-52	87.70	.9515	83.45
1952-53	92.30	.9890	91.28
1953-54	95.31	1.0220	97.41
1954-55	90.60	1.0410	94.31
1955-56	89.40	1.0555	94.36
1956-57	92.90	1.1215	104.19
1957-58	91.10	1.1590	105.58
1958-59	88.30	1.1910	105.17
1959-60	90.10	1.2795	115.28

[1] Frozen pea crop year beginning June 1 and ending May 31.
[2] *Source:* (80).
[3] See Appendix Table 34 for source and method of calculation.
[4] Column 2 times column 3.

Appendix Table 36. Cold storage holdings of frozen peas on December 31 as a percentage of production of peas for freezing, United States, 1947-59

Crop year[1]	United States production of peas for freezing[2]	Cold storage holdings of frozen peas Dec. 31[3]	Cold storage holdings as a percent of production[4]
	Tons	*Tons*	*Percent*
1947-48	72,030	55,826.5	77.5
1948-49	72,420	46,464.5	64.2
1949-50	74,240	45,413.0	61.2
1950-51	97,450	52,602.0	54.0
1951-52	120,620	65,160.5	54.0
1952-53	118,190	70,545.5	59.7
1953-54	129,200	77,972.5	60.4
1954-55	117,280	61,286.5	52.3
1955-56	133,740	62,323.5	46.6
1956-57	199,490	109,541.5	54.9
1957-58	158,830	117,430.0	73.9
1958-59	137,510	96,282.0	70.0
1959-60	170,230	102,838.0	60.4

[1] Frozen pea crop year beginning June 1 and ending May 31.
[2] *Source:* (80).
[3] *Source:* (74).
[4] Column 3 divided by column 2.

Appendix Table 37. Population estimates by states, 1959[1]

State	Population July 1, 1959	State	Population July 1, 1959
	Thousands		*Thousands*
Maine	949	Virginia	3,992
New Hampshire	592	West Virginia	1,965
Vermont	372	Kentucky	3,125
Massachusetts	4,951	North Carolina	4,530
Rhode Island	875	South Carolina	2,417
Connecticut	2,415	Tennessee	3,501
New York	16,495	Georgia	3,838
Pennsylvania	11,323	Alabama	3,193
New Jersey	5,930	Mississippi	2,185
Maryland	3,031	Florida	4,761
Delaware	454	Arkansas	1,744
District of Columbia	840	Louisiana	3,166
Ohio	9,700	Texas	9,513
Indiana	4,638	Oklahoma	2,276
Michigan	7,960	California	14,639
Wisconsin	4,010	Nevada	280
Illinois	10,205	Utah	880
Minnesota	3,399	Arizona	1,233
North Dakota	642	New Mexico	879
South Dakota	687	Colorado	1,682
Iowa	2,809	Oregon	1,766
Nebraska	1,456	Washington	2,823
Kansas	2,140	Idaho	664
Missouri	4,243	Montana	687
		Wyoming	319
		TOTAL	176,174

[1] Excludes Hawaii and Alaska. *Source:* (81).

Appendix Table 38. Population estimates by consuming regions, 1959[1]

Region	Population July 1, 1959
	Thousands
Region 1	
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	10,154
Region 2	
New York, Pennsylvania, New Jersey, Maryland, Delaware, District of Columbia	38,073
Region 3	
Ohio, Indiana, Michigan	22,298
Region 4	
Wisconsin, Illinois	14,215
Region 5	
Minnesota, North Dakota, South Dakota	4,728
Region 6	
Iowa, Nebraska, Kansas, Missouri	10,648
Region 7	
Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Georgia, Alabama, Mississippi, Florida	33,507
Region 8	
Arkansas, Louisiana, Texas, Oklahoma	16,699
Region 9	
California, Nevada, Utah, Arizona, New Mexico, Colorado	19,593
Region 10	
Oregon, Washington, Idaho, Montana, Wyoming	6,259
Total	176,174

[1] *Source:* See Appendix Table 37.

Appendix Table 39. Population estimates by states, 1970[1]

State	Estimated population 1970	State	Estimated population 1970
	Thousands		*Thousands*
Maine	1,012.	Virginia	4,455.5
New Hampshire	647.	West Virginia	2,134.5
Vermont	398.5	Kentucky	3,214.5
Massachusetts	5,500.5	North Carolina	5,148.
Rhode Island	924.5	South Carolina	2,733.5
Connecticut	2,787.	Tennessee	3,978.
New York	19,399.5	Georgia	4,228.5
Pennsylvania	12,384.	Alabama	3,401.
New Jersey	6,679.5	Mississippi	2,179.5
Maryland	3,802.	Florida	5,411.
Delaware	546.	Arkansas	1,634.5
District of Columbia	1,058.5	Louisiana	3,639.
Ohio	11,533.	Texas	11,278.5
Indiana	5,528.	Oklahoma	2,083.
Michigan	9,921.	California	19,679.
Wisconsin	4,468.	Nevada	385.
Illinois	11,097.5	Utah	1,098.
Minnesota	3,765.5	Arizona	1,614.
North Dakota	662.5	New Mexico	1,114.5
South Dakota	737.5	Colorado	2,049.
Iowa	2,911.	Oregon	2,409.
Nebraska	1,505.5	Washington	3,569.
Kansas	2,353.	Idaho	749.
Missouri	4,756.5	Montana	739.
		Wyoming	387.
		TOTAL	203,689.5

[1] Excludes Hawaii and Alaska. *Source:* The average of Series 2 and 3 estimates (81).

Appendix Table 40. Population estimates by consuming regions, 1970[1]

Region	Estimated population 1970
	Thousands
Region 1	
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	11,269.5
Region 2	
New York, Pennsylvania, New Jersey, Maryland, Delaware, District of Columbia	43,869.5
Region 3	
Ohio, Indiana, Michigan	26,982.
Region 4	
Wisconsin, Illinois	15,565.5
Region 5	
Minnesota, North Dakota, South Dakota	5,165.5
Region 6	
Iowa, Nebraska, Kansas, Missouri	11,526.
Region 7	
Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Georgia, Alabama, Mississippi, Florida	36,884.
Region 8	
Arkansas, Louisiana, Texas, Oklahoma	18,635.
Region 9	
California, Nevada, Utah, Arizona, New Mexico, Colorado	25,939.5
Region 10	
Oregon, Washington, Idaho, Montana, Wyoming	7,853.
TOTAL	203,689.5

[1] *Source:* See Appendix Table 39.

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