4-1-1975

A Consideration of Exogenous Changes in Prices in a Regional Input-Output Model

Chinkook Lee
University of Washington

Leroy Blakeslee
University of Washington

Walter Butcher
University of Washington

A CONSIDERATION OF EXOGENOUS CHANGES IN PRICES IN A REGIONAL INPUT-OUTPUT MODEL

by

Chinkook Lee, Leroy Blakeslee, and Walter Butcher

For Presentation At The
Southern Regional Science Association Meetings
Atlanta, Georgia
April, 1975

A CONSIDERATION OF EXOGENOUS CHANGES IN PRICES IN A REGIONAL INPUT-OUTPUT MODEL

Chinkook Lee, Leroy Blakeslee, and Walter Butcher*

One of the assumptions of standard input-output analysis is that there are no changes in the relative prices. This assumption makes it possible to employ a conveniently simple algorithm for an input-output analysis. However, in the increasingly popular application of input-output analysis to regional economics, the assumption of constant relative prices is clearly at odds with experience. Many commodities are widely traded and their prices are determined in national or international markets. For those goods, an individual region is a price taker and the impact of a price change may be quite considerable. The purpose of this paper is to report a method which has been developed for incorporating those exogenous price changes into input-output analysis and thereby estimating their impact upon a regional economy.

General Equilibrium and Partial Disequilibrium

The concept of general static equilibrium has been widely accepted and applied since its early explicit formulation by Walras[1]. There are, to be sure, problems and hence critics, but a concept that explains why and how all prices and quantities are related has much appeal. It is entirely reasonable that Leontief would base his famous input-output formulation of the U.S. economy upon static general equilibrium concepts.

A central feature of general equilibrium is complete interdependence among all commodities. As a result, changes in any one price will bring forth an immediate reaction of changes in all other prices. According to the homogeneity

---

* Post-doctoral Research Associate, Associate Professor, and Professor respectively in the Department of Agricultural Economics, Washington State Univ.

1. Leon Walras, Elements of Pure Economics, Trans. W.Jaffe, Homewood, Ill. Richard Irwin, Inc., 1954

postulate, which was so named by Leontief[2], equiproportionate changes in the prices of all goods have no effect upon commodity markets since demand functions are homogenous of degree zero in respect to relative prices.

The concept of general equilibrium is closely related to the long run equilibrium of the firm in perfect competition. In long-run equilibrium, the price of goods must exactly equal unit costs of production including both the costs of other intermediate goods and direct labor costs. Leontief's formulation is true to this feature to an extreme degree. His linear homogeneous production functions assure that prices will be determined only by technical production relationships and the returns to labor - the only primary input. Following Dorfman-Samuelson-Solow's[3] notation, let $P_i a_{ij}$ be the cost per unit for the j-th good of the needed i-th input and $P_0 a_{0j}$ be the direct-labor cost (wage times needed labor). Then, for each of the n produced goods, the following market conditions will exist:

$$(1) \qquad P_j = P_0 a_{0j} + P_1 a_{1j} + P_2 a_{2j} + \ldots + P_n a_{nj} \qquad j = 1,2, \ldots, n$$

The equilibrium price of goods and services exactly covers the unit cost of production. This situation, when looked at graphically, can be depicted in Figure 1. That is, point e (on the left side) or E (on the right side) of Figure 1 are equilibrium points where producers make only normal profit. Under Leontief's system, the a_{ij}'s and a_{oj} are constants so that equation (1) becomes an expression among prices themselves and is homogeneous of degree one. Regarding this system of linear equations with the prices as the only unknowns, Leontief has said:

---

[2] Wassily Leonlief, "The Fundamental Assumptions of Mr. Keynes' Monetary Theory of Unemployment," Quarterly Journal of Economics, LI (1936-37), 193.

[3] Dorfman-Samuelson-Solow, Linear Programming and Economic Analysis, New York, McGraw-Hill Book Co., 1958, p. 125.

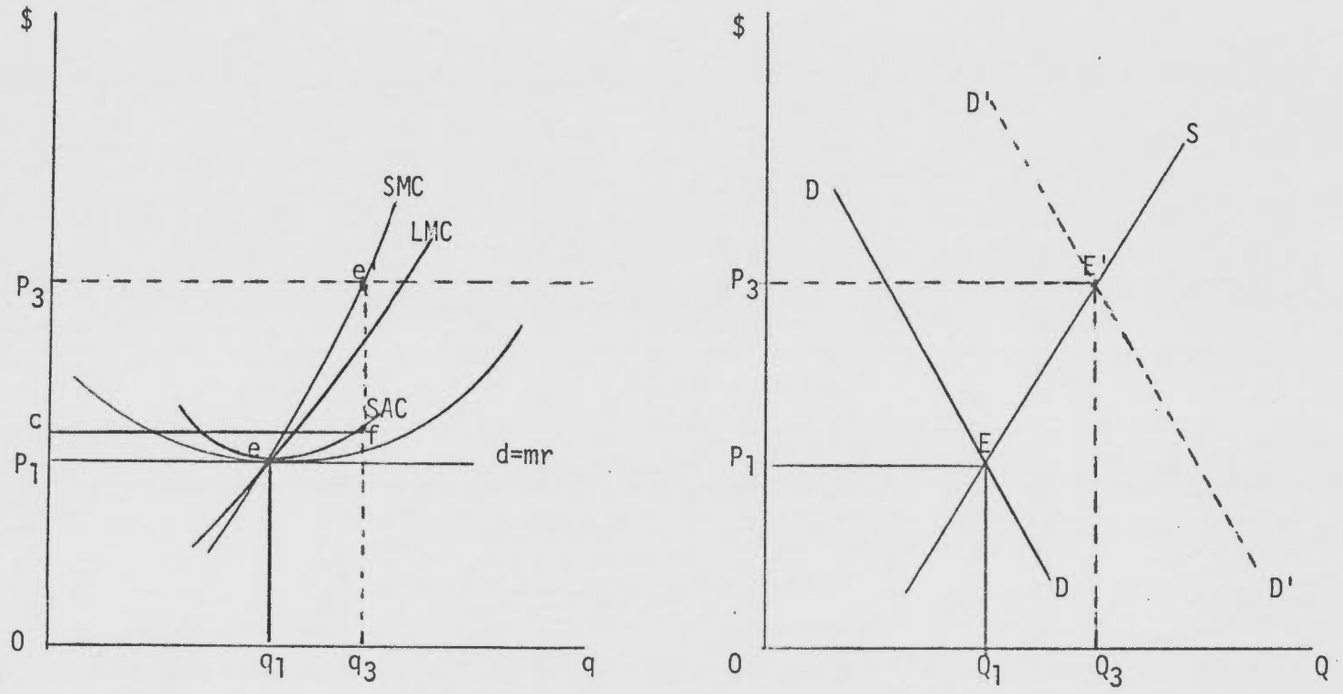

Figure 1.-- Short-run market equilibrium and profit in the firm.

> The system is homogeneous: if satisfied by some given set of prices, it will be equally well satisfied by any other set obtained from the first by multiplying it by any given number. The proposition that the material structure of our economic system determines only relative, not the absolute, prices of all the commodities is so familiar that it hardly deserves further discussion.[4]

In the Leontief system, labor is the only primary input so that relative prices of commodities will depend only on their direct and indirect labor costs. Any change in the wage rate in equation (1) will increase the price of all other commodities in the same proportion. Thus, relative prices are constant in the Leontief system.

The economies of individual subregions, may, however, deviate from the general equilibrium postulated for the national economy for either of two important reasons. First, the production function for an individual region may differ significantly from the function for the economy as a whole, leading to a situation in which costs of production in the region differ greatly from the national cost-determined prices. Second, individual regions need not have a balanced monetary system. Accounts are "open" with the rest of the nation and wealth transfers may occur instead of the general equilibrating price adjustments expected at a national level. Although the disequilibria arise due to forces that are external and beyond the control of the region, the consequences of these effects are often the dominant factors affecting various types of regional economic activity. The magnitude and dispersion of those impacts will depend on the structure of the regional economy and the importance of the commodities whose prices have been subject to exogenous change.

Figure 1 shows a hypothetical situation for Washington wheat producers. Their price is determined by national (and international) markets for wheat. Suppose that the equilibrium was initially at points e and E, but the increased export demands shifts the national market demand curve to D' D' from DD . The new short-run equilibrium situations are depicted at E' for the industry and at

---

[4] Leontief, The Structure of American Economy; 1919-1939, p.46.

e for the Washington wheat producers. Since Washington State wheat producers are price-takers, (i.e. the wheat price is determined in the national market rather than by the supply and demand for Washington wheat) an increase in the price of wheat in the national market due to international trade is an exogenous change for Washington State wheat producers. As a result, demand growth in the national market is reflected to regional wheat producers by the new price, P_3 which intersects the short-run marginal cost curve at e'. At this point, long run marginal costs and short run average costs are below price and producers will make e f units of profit per unit of output. Total profits will equal the retangular area shown by "p_3e' fc".

At least two things having significance for regional economic analysis will happen in this short-run situation. First, the exogenous change in the price of wheat results in changes in relative prices. Second, a rise in the price of wheat will result in profits for wheat farmers and real-income losses to wheat consumers. If all the wheat produced is consumed with the state, the price change would result in a significant transfer in favor of Washington wheat farmers and at the expense of Washington consumers. However, due to the openness of the regional economy, and large wheat exports, it is possible that purchasers from outside of Washington State will bear much of the loss whereas the region enjoys the income increase. Thus, the income effects within the region will be nonzero and asymmetric.

But most important, as we move from long-run equilibrium considerations to the short-run, we recognize that the ridgidity implied in equation (1) is no longer applicable. Cost of fixed factors need not be exactly covered, and in fact, returns to fixed factors are established as a residual after paying all variable costs. In this case, equation (1) can be written as:

(2) $P_j \geq P_0 a_{0j} + P_1 a_{1j} + P_2 a_{2j} + \ldots + P_n a_{nj}$ $j = 1, 2, \ldots, n.$

This equation shows that certain profits occur due to the price increase as compared to zero profits in the long-run competitive equilibrium situation. This short-run situation and the accompanying positive or negative profits are more likely to occur in a regional economy when the prices are exogenously changed.

Mathematical Input-output Model for Price Changes

Our objective is to model the relationship between a set of endogenous variables consisting of sector outputs, factor purchases, consumption, imports and income; and a set of exogenous variables consisting of sector final demands, prices, and autonomous income. The price set is broken down into domestic prices of goods and services which are produced, import prices, and the wage rate, though in the empirical work we consider only the effects of domestic price changes.

Two matters are given special emphasis in model construction. First we attempt to model factor demand and income generation in a way which recognizes the constraints on short-run firm and industry behavior under conditions where the industry (regional industry in this case) has little control over output and input prices. Second, we emphasize development of a modelling framework within which solutions are computable in terms of the kinds of aggregate sectoral outputs and price indicators which typically appear in empirical input-output studies.

We begin our discussion of the model with a statement of the assumptions underlying it. First, we assume that all prices, physical final demand, and autonomous income payments to the regional economy may be treated as exogenous variables generated outside the system under study. The assumption of exogenous price determination applies to prices of goods and services produced within the regional economy, to import prices, and to wage rates.

Technical coefficients, those measuring physical input use per unit of physical output, are assumed to be fixed for all variable inputs. For all outputs and inputs used, the measure of physical quantity used is "dollars worth at base

period prices." (1967 is the base period in later examples). With this convention, all prices in the base period are unity. However, prices in general are not regarded as fixed either absolutely or relatively. Thus, we have

$$q_{ij} = a_{ij} O_j$$

$$L_j = w_j O_j$$

$$M_{ij} = m_{ij} O_j$$

where q_{ij}, L_j, M_{ij}, and O_j are, respectively, quantity of product purchased by sector j from sector i, quantity of labor purchased by the j-th sector, quantity of the i-th import purchased by the j-th sector, and output of the j-th sector. All are regarded as variables. Because of the units of measurement, their values in the base period are the same as the market value of flows, but they may take on other values as the exogenous variables change. The terms a_{ij}, w_j, and m_{ij} are fixed constants which measure variable input use per unit of output for any level of output and input which are measured in "dollars worth at base period prices". Of course, with these units of physical output, the technology coefficients are numerically the same as the value of input purchases per dollar of output observed in the base period.

Household consumption is assumed to be endogenous and is a function of income received by consumers in the regional economy. Specifically, we have assumed that the value of household consumption of the i-th commodity is proportional to income. The proportionality constant, c_i, is given as

$$c_i = P_i^o S_i^o / Y^o,$$

where P_i^o is base period price, S_i^o is base period consumption of commodity i, and Y^o is base period income. The actual consumption function used is in the form

$$S_i = c_i \, Y/P_i.$$

It is assumed to model the relationship between consumption, income and price for all levels of income and price.[5]. Here, Y is measured in current prices, and S_i is measured in base period prices.

Total income in the economy is modeled as the sum of three items. The first is autonomous income, Y_a. Second are wage payments. Using P_ℓ to represent the money wage rate, total wages are given as $P_\ell \sum_j L_j$, or as $P_\ell \Sigma w_j O_j$. The third component consists of gross returns to fixed capital, and returns to labor and management in owner-operated firms. In the short run, the third components is a residual which remains after all variable costs including wages have been paid out of total revenue. The total of these residual earnings in the j-th sector is denoted r_j, and the total in the economy is R.

The Structural Equations

The formal model consists of three sets of equations. All are related to standard Input-Output structures. The first set are the market clearing equations. They require that each producing sector's output equal to sum of inter-industry demand plus household consumption plus exogenous final demand all measured in value terms. These equations may be written as:

$$(1)\quad P_i \Sigma_j a_{ij} O_j + P_i S_i + P_i t_i = P_i O_i \ ; \text{ or}$$

$$P_i \Sigma_j i_j O_j + c_i Y + P_i t_i = P_i O_i \ ; \ i=1,2 \ . \ . \ ., \ n.$$

The symbol t_i represents a physical quantity of exogenous final demand for the output of sector i. The terms in equation 1 may be translated into convenient matrix form by introduction of the following definitions.

D_p = an n x n diagonal matrix having prices P_i down the principal diagonal.

A = an n x n matrix of technology coefficients, a_{ij}.

---

[5]Two things should be noted about this function. First, both income and price elasticities are unity. Second, while there are no substitute prices in the function, there are generally secondary effects such that the partial derivative of the i-th demand with respect to the j-th price need not be zero. This occurs through an income effect wherein $(\partial S_i/\partial Y)(\partial Y/\partial Pj) \neq 0$

$\emptyset$ = an n x 1 column vector of physical output levels, O_j.

C = an n x 1 column vector of marginal propensities to consume, c_i.

t = an n x 1 column vector of physical final demands, t_i.

Using these definitions, we may write (1) as (2).

(2) $D_p A\emptyset + CY + D_p t = D_p \emptyset$; or

$D_p(I-A)\emptyset - CY = D_p t$

The second component of the model is a single equation that defines income as

(3) $Y = \sum_j r_j + P_\ell \sum_j w_j O_j + Y_a$

Using the symbol ℓ to represent a 1 x n row vector of ones and w for a row vector of w_j's, we may express this as in equation (4).

(4) $Y = r\ell' + P_\ell w\emptyset + Y_a$

The third component of the model is an expression which defines residual earnings in each sector.

(5) $r_j = P_j O_j - \sum_i P_i a_{ij} O_j - P_\ell w_j O_j - \sum_i P_{mi} m_{ij} O_j$; $j=1, 2, \ldots, n$

Here, P_{mi} is the price of the i-th class of import goods used in production. All other symbols were defined earlier. Now let D_{pm} equal a diagonal matrix with import prices down the principal diagonal; let D_o equal a diagonal matrix of sector outputs, O_j; and let m be a matrix of technical coefficients defining quantity of the i-th import per unit of output, m_{ij}. With these definitions, we define the vector of residuals, r, as in equation (6).

(6) $r = (\ell D_p(I-A) - P_\ell w - \ell D_{pm} m)\, D_o$

Under our assumptions, equations 2,4, and 6 constitute the model, and they state how the jointly endogenous variables $\emptyset$, (or D_o), Y and r are related to the exogenous variables t, Y_a, and D_p (prices). We now wish to consider procedures for

solving for the endogenous variables, given the exogenous variables.

Solution Procedures

As a first step in the solution procedure, we introduce a slightly different way of expressing the prices and final demands which appear in the model. In applied Input-Output work, each sector's output is actually a mix of not entirely homogeneous products, and no single commodity price can be used to value it. Indexing is a commonly used procedure to represent changes in such aggregates and their prices. A similar method has been adopted here. Wherever a price appears in the model it is replaced by $(P_i/P_i^o)(P_i^o)$, where P_i^o is the price of the i-th commodity in the base period. P_i/P_i^o is simply an index number expressing any other price for the i-th commodity relative to the base price. Where sector i produces more than one commodity, the index number would be a weighted average of the price relative for the commodities which the sector produces. Because of the units of measurement for physical output which have been chosen, P_i^o is equal to 1.0 in all cases, and we simply replace P_i with P_i/P_i^o wherever P_i appears in the model. This same procedure may be used to represent changes in labor price and in import prices, though in the examples which follow these prices are always held constant at base period values.

In a similar fashion, we also replace t_i wherever it appears in the model with the equivalent expression $(t_i/t_i^o)(t_i^o)$. Here again t_i/t_i^o may be interpreted as an index of physical final demand relative to that in the base period. We represent a change in physical final demand by multiplying the base period value by an index of change in real final demand.

In the following we define $D_{\Delta p}$ as a diagonal matrix with non-zero elements P_i/P_i^o; ΔP_ℓ is P_ℓ/P_ℓ^o; $D_{\Delta Pm}$ is a diagonal matrix with non-zero elements P_{mi}/P_{mi}^o; and $D_{\Delta t}$ is a diagonal matrix with non-zero elements t_i/t_i^o. After making the

indicated substitutions in equations (2), (4), and (6) and collecting the results in matrix equation form we get equations (7), (8), and (9) as the complete model.

(7) $D_{\Delta p}(I-A)\emptyset - CY = D_{\Delta p}D_{\Delta t}t^{o}$

(8) $Y = r\ell' + \Delta P_{\ell} w\emptyset + Y_a$

(9) $r = (\ell D_{\Delta p}(I-A) - \Delta P_{\ell} w - \ell D_{\Delta Pm} m)D_o$

The solution to the model is obtained by elimination. First eliminate Y by substituting equation (8) for Y in equation (7). This gives equation (10)

(10) $(D_{\Delta p}(I-A) - \Delta P_{\ell} Cw)\emptyset - Cr\ell' - CY_a = D_{\Delta p}D_{\Delta t}t^{o}$

Equation (9) can then be used to eliminate r from equation (10), yielding

(11) $(D_{\Delta p}(I-A) - \Delta P_{\ell} Cw)\emptyset - C(\ell D_{\Delta p}(I-A) - \Delta P_{\ell} w - \ell D_{Pm} m)D_o\ell' - CY_a = D_{\Delta p}D_{\Delta t}t^{o}$

Lastly we note that

$D_o\ell' = \emptyset$ so that equation (11) may be simplified to

(12) $\{ (I-C\ell)D_{\Delta p}(I-A) + C\ell D_{\Delta Pm} m\} \emptyset = CY_a + D_{\Delta p}D_{\Delta t}t^{o}$

Given $D_{\Delta p}$, $D_{\Delta t}$, ΔP_{ℓ}, $D_{\Delta Pm}$, Y_a, and t^{o}, the matrix in brackets on the left hand side of (12) may be evaluated. In general it will be non-singular, and if equation (12) is miltiplied on the left by its inverse, a solution for $\emptyset$ is obtained. This may be interpreted as a measure of physical output which would result given the stated values of the exogenous variables. Actually, the values therein are sector outputs measured in base period prices. The solution from (12) may then be used to form D_o, and this, together with the appropriate exogenous variables may be used to solve for r by evaluating equation (9). Solution values for r and $\emptyset$, together with Y_a and ΔP_{ℓ}, are then substituted into equation (8) in order to

solve for Y. If values of output in the new prices are desired, they may be obtained by evaluating the expression $D_{\Delta p}\emptyset$, where $\emptyset$ is the solution vector giving sector outputs measured in base period prices.

The 1967 Washingtin Input-Output Tables

In this section the model presented in previous sections is investigated using 1967 Washington State input-output tables.[6] Table 1 shows the 1967 transaction table for the Washington economy in millions of dollars at producer's prices. The first 35 rows and columns show interindustry flows in the Washington economy. Column 36 shows personal consumption expenditures by Washington households. These are assumed to be endogenously determined, therefore, column 36 is excluded from the final demand sectors. Columns 37 through 41 are final demand sectors. Column 42 reports estimated total gross sales of each sector and column 43 shows estimated total net sales of each sector.

In the empirical analysis of this study, the "netting-out" method is used.[7] Thus, total net sales of industries will be total sales minus the amounts consumed by the same industries. In the empirical computation, therefore, all intra-sector purchases will be zero, including zero direct income generation via personal consumption. Entries in row 36 and 37 are estimates of imports from the rest of the U.S. and from foreign countries, respectively. Row 38 is the total value created by each industry and consists of wage payments and residual income as defined in the previous section. Row 39 shows the wage payments and row 40 shows residual incomes.

Table 2 lists purchases by Washington industries per dollar of total output and purchases by households per dollar of value created. This table is derived

---

[6] Beyers, William B., et. al., Input-output Tables for Washington Economy, 1967.

[7] Leontief assumes that an industry does not use any of its own products or inputs in producing its product (Leontief Op.cit., p.35). Dorfman, Samuelson, and Solow also say this method is a harmless convention in the static model (Dorfman, Samuelson, and Solow, Op.cit., p.205).

Table 1. --Transaction table for Washington input-output economy.

Selling Industries \ Purchasing Industries	Wheat	Other Field Crops	Vegetables & Fruits	Livst. & Products	Other Agr. Products	For., Fish., & Min.	Meat & Dairy Prod.	Canning & Preserv.	Grain Mills	Bev. & Other Foods	Textiles & Apparel	Lumber & Wood	Plywood	Paper Products	Printing & Publish.	Chem. & Allied Prod.	Pet. & Pet. Products	Stone, Clay, & Glass	Iron & Steel	Nonferrous Metals	Aluminum	Fabricated Metals	Machinery
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Wheat	6.2	-	-	7.7	-	-	-	-	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Other Field Crops	-	2.8	-	26.9	-	-	-	.9	2.0	.8	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Vegetables & Fruits	-	-	.5	-	-	-	.2	83.7	-	19.9	-	-	-	-	-	.1	-	-	-	-	-	-	-
4. Livst. & Products	-	-	-	31.2	-	-	173.4	-	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Other Agr. Products	-	-	.5	3.2	1.5	2.4	-	.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. For., Fish., & Min.	-	-	.2	-	-	4.1	-	10.9	-	.8	-	145.3	5.1	.1	-	.2	-	18.2	.2	8.9	-	-	-
7. Meat & Dairy Prod.	-	-	-	-	-	1.8	36.6	2.8	1.8	1.7	.1	-	-	-	-	-	-	-	-	-	-	-	-
8. Canning & Preserv.	-	-	-	-	-	.2	-	.5	.1	.1	-	-	-	-	-	-	-	-	-	-	-	-	-
9. Grain Mills	-	-	-	31.8	-	-	.2	.1	1.6	.7	-	-	-	-	-	-	-	-	-	-	-	-	-
10. Bev. & Other Foods	-	-	-	1.2	-	.1	1.2	9.5	1.7	14.4	-	-	-	-	-	.1	-	-	-	-	-	-	-
11. Textiles & Apparel	.4	.1	-	-	-	1.3	-	-	-	-	2.8	.3	-	.9	-	-	-	-	-	-	-	-	-
12. Lumber & Wood	-	-	1.1	-	-	.1	.3	-	-	-	-	155.6	41.8	59.3	-	-	-	.2	-	.3	.3	.5	.1
13. Plywood	-	-	-	-	-	-	-	-	-	-	-	3.8	10.9	.8	-	-	-	-	-	-	.7	.2	.2
14. Paper Products	.1	.1	.8	-	.2	-	3.8	8.7	.2	12.6	.3	.4	.3	67.8	7.7	.3	1.8	1.8	-	-	-	.6	.6
15. Printing & Publish.	-	-	-	-	-	-	-	1.7	.2	1.3	-	-	.1	.3	.2	.1	-	-	-	-	-	-	.2
16. Chem. & Allied Prod.	6.4	1.6	3.3	1.8	.5	.6	.3	.2	-	.6	.1	1.0	1.6	17.6	-	6.8	1.8	.1	-	-	-	1.2	.1
17. Pet. & Pet. Products	4.4	1.9	5.5	2.7	.5	4.4	.3	.5	.2	1.9	-	4.8	.5	5.7	-	2.5	3.2	2.9	-	.1	.1	.8	.3
18. Stone, Clay, & Glass	-	.1	.8	.7	-	.1	.3	1.6	-	7.1	-	.1	-	.2	-	.1	-	9.8	1.8	.1	-	-	-
19. Iron & Steel	.1	-	-	-	-	-	-	-	-	-	-	.3	-	.2	-	.2	-	-	1.8	.1	.5	6.0	9.8
20. Nonferrous Metals	-	-	-	-	-	-	-	-	-	-	-	-	-	.5	-	-	-	-	-	.9	-	.1	1.2
21. Aluminum	.3	.2	-	-	-	-	-	-	-	-	-	.1	-	-	-	.2	-	-	-	-	5.8	9.0	3.4
22. Fabricated Metals	.1	.1	.3	.2	-	-	1.7	21.2	-	42.3	-	1.7	2.7	.7	.5	1.4	.1	.8	-	-	-	4.0	2.6
23. Machinery	.1	.1	-	-	-	.7	-	-	-	.1	-	2.3	.3	8.1	-	.1	-	.1	.8	.7	.4	.7	8.6
24. Aerospace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25. Other Transportation	-	-	-	-	-	.6	-	-	-	-	-	.1	-	.3	-	-	.1	-	-	-	-	-	.3
26. Other Manufacturing	-	-	-	-	-	-	.1	-	-	-	1.1	.3	.2	.4	.1	.1	-	.1	.1	-	-	3.7	1.5
27. Construction	1.0	.3	1.1	.9	.1	.1	.4	.6	.1	.3	-	1.2	.6	1.5	.1	.4	2.6	.2	.2	.1	.7	.1	.1
28. Transp. Services	1.0	.3	1.3	5.6	.2	2.4	13.4	11.7	2.1	7.0	-	49.8	8.7	19.0	.4	2.5	9.0	10.2	1.8	-	8.2	1.2	.7
29. Communication	.2	.7	1.2	1.4	.2	.6	.9	.9	.2	2.0	.7	2.6	.4	1.1	1.0	1.0	.2	.5	.1	.1	1.0	.6	1.7
30. Elect. Services	1.5	.2	1.3	1.1	.2	.3	.7	.7	.2	.6	.5	6.4	.7	8.0	.4	7.1	1.9	1.5	1.3	.1	25.5	.8	1.5
31. Natural Gas Serv.	-	-	-	-	-	.2	1.3	.9	.4	.6	-	1.6	.3	10.0	.3	6.2	4.2	6.0	2.6	.9	.5	1.4	2.0
32. Water, San., & Irr.	1.7	.5	1.6	1.6	.2	-	.5	.9	-	.7	.1	-	.1	.9	.1	.7	.9	-	-	-	1.1	-	.3
33. Trade	2.4	.8	4.2	6.4	.7	1.2	7.8	14.7	1.5	7.3	.3	11.9	4.2	15.2	.8	3.0	.2	2.2	3.4	.1	.2	2.3	1.9
34. Fin., Ins., & R.E.	1.9	.8	1.7	1.6	.2	1.2	2.2	1.5	.5	2.4	.6	6.6	1.5	4.6	1.6	1.2	4.1	1.0	.8	.2	3.8	2.4	2.0
35. Services	4.9	1.8	4.5	9.5	.7	4.2	2.8	4.2	.9	2.3	1.0	5.2	2.4	3.4	5.3	4.4	2.0	3.5	1.6	.2	3.0	2.5	9.7
36. Imports - U.S.	16.9	6.4	21.4	44.0	3.9	21.5	150.4	86.8	81.9	74.4	44.3	59.6	53.4	137.0	25.6	70.4	44.2	14.4	19.7	17.1	215.1	72.2	99.0
37. Imports - Foreign	2.1	3.3	2.1	1.0	.5	5.1	3.9	.4	1.2	.7	1.9	13.0	15.9	19.3	9.6	.1	206.3	-	.6	19.6	104.6	24.2	2.4
38. Value - Created	115.0	33.6	208.6	90.1	25.7	213.3	100.0	129.0	21.8	214.8	28.2	329.8	76.1	424.0	115.8	128.5	132.2	95.5	54.2	11.6	183.4	127.4	182.3
39. Wages	16.2	5.3	39.6	17.0	11.7	43.1	49.1	31.1	11.1	58.7	24.9	242.9	68.4	162.7	71.4	63.9	15.1	41.9	28.1	7.6	78.5	65.3	113.5
40. Residuals	98.8	28.3	169.0	73.1	15.0	170.2	50.9	97.9	10.7	156.1	14.3	86.9	7.7	261.3	44.4	65.0	117.1	53.6	26.2	4.0	104.9	62.1	68.8
41. Gross Total	166.7	55.5	261.4	259.6	36.3	265.5	502.7	334.2	126.6	418.9	72.8	800.3	229.8	826.9	169.5	240.1	413.2	168.2	90.0	58.0	556.7	261.9	332.3
42. Net Total	160.5	52.7	260.9	238.4	34.9	261.4	466.1	393.7	125.0	434.4	90.0	644.4	213.9	739.1	169.3	231.3	410.0	152.4	89.8	57.3	551.3	257.9	323.7

Data taken from Beyers, William B., Phillip J. Bourque, Warren R. Seyfried, and Elson E. Weeks, Input-Output Tables for the Washington Economy, 1967, Seattle, Washington.

Table 1. (Continued)

Aerospace	Other Transportation	Other Manufacturing	Construction	Transp. Services	Communication	Elect. Services	Natural Gas Serv.	Water, San., & Sev.	Trade	Fin., Ins., & R.E.	Services	Washington Personal Consumption	Washington State and Local Government	Washington Capital Investment	Federal Expenditures	Exports to U.S.	Exports to Foreign	Total Sales	Total Net Sales
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.0	127.6	166.7	160.5
-	-	-	-	-	-	-	-	-	-	-	-	.1	-	-	-	16.1	7.9	55.5	52.7
-	-	-	-	.3	-	-	-	-	-	-	-	22.7	.1	-	-	114.0	19.9	261.4	260.9
-	-	-	-	-	-	-	-	-	-	-	-	50.3	-	-	-	12.0	1.3	269.6	238.4
-	-	-	1.5	-	-	-	-	-	.1	-	-	15.7	.9	-	-	9.2	.5	36.3	34.8
-	-	-	18.3	-	-	-	-	-	-	-	-	14.7	8.3	-	.6	29.2	4.3	265.5	261.6
-	-	.6	-	4.0	-	-	-	-	7.1	-	4.0	359.8	4.5	-	22.7	50.3	6.7	502.7	466.1
-	-	-	-	-	-	-	-	-	.1	-	2.0	94.3	.1	-	12.0	279.7	5.1	394.2	393.7
-	-	-	-	.1	-	-	-	-	-	-	1.0	1.6	-	-	2.4	68.0	19.9	126.6	125.0
-	-	-	-	1.7	-	-	-	-	7.9	-	.3	154.8	1.9	-	12.6	202.2	10.2	418.8	404.6
.2	.3	.5	-	-	-	-	-	-	.5	-	1.4	16.5	.1	-	.3	67.2	-	92.8	90.0
.2	.5	5.4	85.0	2.3	.1	1.6	1.0	.1	-	-	.1	4.0	1.2	1.2	2.0	380.3	53.4	800.0	644.4
.2	.2	1.2	38.9	3.0	-	-	-	-	-	-	-	1.3	2.3	3.5	4.5	152.8	1.1	225.8	213.9
1.5	-	1.7	.2	.4	1.3	-	-	-	18.0	2.0	4.0	99.8	1.4	-	16.4	471.0	84.9	826.9	739.1
1.5	.3	.4	.2	.5	1.1	.1	-	-	60.0	8.3	32.5	54.8	1.2	-	2.5	2.2	-	169.5	169.3
2.8	.3	1.0	17.0	1.2	-	.1	-	.3	4.2	-	7.9	1.3	.3	-	145.3	10.6	3.0	249.1	231.3
2.8	.3	.3	16.9	40.0	.6	.4	-	.1	20.0	1.9	8.6	177.2	9.2	-	16.5	75.5	1.1	413 2	413 0
-	.1	-	135.0	.2	-	-	-	-	.3	-	1.3	2.8	.8	-	3.0	1.6	.9	168.2	158.4
1.0	10.9	.1	42.3	1.0	-	.2	-	-	1.0	-	-	.1	-	-	.6	11.3	3.5	90.0	89.0
.5	1.2	-	.5	.2	.2	.1	-	-	-	-	.1	-	-	-	.4	17.1	35.0	58.0	57.1
20.5	2.9	.3	8.4	-	-	.1	-	-	-	-	-	-	-	6.2	-	499.5	-	556.1	551.1
3.8	1.3	1.1	133.3	.1	-	1.0	.9	.2	.9	-	1.2	1.6	2.9	5.6	.4	24.3	2.9	261.9	257.9
15.8	2.6	.8	2.0	.9	4.8	.3	-	-	6.0	-	5.3	3.2	2.9	17.8	95.0	121.7	21.9	332.3	323.7
58.5	-	-	-	4.5	-	-	-	-	-	-	-	-	-	-	494.5	1585 6	393.1	2534 0	2477.5
-	5.6	-	2.5	8.5	-	.1	-	-	2.0	-	-	12.7	3.0	5.4	256.5	103.7	5.8	437.2	431.6
1.7	-	1.1	-	-	.5	.1	-	-	2.8	1.2	4.6	21.6	12.1	.3	1.8	55.3	.4	111.2	110.1
1.5	.5	.1	.2	9.9	3.0	4.4	1.0	1.0	3.3	5.8	6.5	36.5	665.7	1259.0	147.7	-	-	2158.4	2158.2
2.1	1.9	.7	39.9	30.0	.1	3.3	-	.5	18.9	4.4	2.1	96.5	6.0	6.0	50.5	278.5	143.8	837.7	827.7
7.8	.7	.4	7.7	9.0	2.2	.8	.1	.1	30.0	6.3	54.8	134.5	11.2	-	3.0	11.0	-	294.7	292.5
4.1	1.2	.6	8.3	3.5	1.4	42.1	.4	2.0	38.0	3.7	21.2	121.8	18.5	-	9.3	25.1	-	361.2	319.1
1.6	.5	.3	1.7	1.5	.4	-	19.5	1.2	10.0	1.2	6.7	23.9	.7	-	3.1	1.7	-	113.6	94.1
.8	.4	.2	.1	-	-	.9	-	.1	1.1	.1	.1	38.8	.9	-	-	-	-	54.8	54.7
3.8	2.4	1.6	83.0	7.9	1.0	1.1	-	-	45.0	11.3	15.6	1910.8	12.8	123.0	9.3	205.5	12.5	2516.3	2471.3
8.7	2.2	.9	16.7	18.2	2.4	3.0	.8	.8	74.8	49.1	29.7	532.2	6.3	4.2	.9	113.9	-	909.5	860.4
32.0	4.3	3.1	48.5	11.1	3.9	14.7	6.5	4.0	116.1	32.0	92.8	1137.0	6.0	-	18.4	38.7	-	1649.1	1556.3
1267.0	154.8	29.2	725.5	175.6	26.8	33.2	41.3	13.4	148.0	29.9	292.6	1423.8	175.2	1594.1	-	-	-	7523.0	7523.0
7.4	1.8	.9	6.8	-	-	3	.2	-	.3	-	-	100.0	-	-	-	-	-	557.3	557.3
1089.0	249.0	58.9	729.0	506.1	244.5	253.3	41.9	30.9	1903.6	752.3	1052.5	1219.7	754.0	-	804.0	-	-	12733.1	11513.4
917.5	83.0	44.4	567.9	338.7	113.8	20.8	19.0	7.3	1229.6	404.1	876.0	-	-	-	-	-	-	5909.0	5909.0
171.5	157.0	14.5	221.1	107.4	130.7	232.5	22.9	23.6	694.2	348.2	176.5	-	-	-	-	-	-	4046.6	4046.6
2536.0	637.2	111.2	2158.6	837.7	278.7	361.2	113.6	54.8	2516.3	909.5	1648.1	7899.1	1712.0	3026.3	2166.0	5057.0	968.5	39528.2	-
2477.5	631.6	110.1	2158.2	807.7	292.5	319.1	94.1	54.7	2471.3	863.6	1556.3	-	-	-	-	-	-	-	37563.3

Graduate School of Business Administration, University of Washington, December 1970.

Table 2i. Purchases by Washington industries and by households per dollar of total output and of value created.

Selling Industries \ Purchasing Industries	Wheat 1	Other Field Crops 2	Vegetables & Fruits 3	Livst. & Products 4	Other Agr. Products 5	For., Fish., & Min. 6	Meat & Dairy Prod. 7	Canning & Preserv. 8	Grain Mills 9	Bev. & Other Foods 10	Textiles & Apparel 11	Lumber & Wood 12	Plywood 13	Paper Products 14	Printing & Publish 15	Chem. & Allied Prod. 16	Pet. & Pet. Products 17
1. Wheat	-	-	-	.0323	-	-	-	-	.0640	-	-	-	-	-	-	-	-
2. Other Field Crops	-	-	-	.1182				.0023	.0160	.0020					-	-	-
3. Vegetables & Fruits	-	-	-	-	-	-	.0004	.2126	-	.0492	-	-	-	-	-	.0004	-
4. Livst. & Products	-	-	-	-	-	-	.3720	-	-	.0035	-	-	-	-	-	-	-
5. Other Agr. Products	-	-	.0019	.0135	-	.0092	-	.0020	-	-	-	-	-	-	-	-	-
6. For., Fish, & Min.	-	-	.0008	-	-	-	-	.0277	-	.0020	-	.2255	.0239	.0001	-	.0009	-
7. Meat & Dairy Prod.	-	-	-	-	-	.0038	-	.0050	.0144	.0042	.0011	-	-	-	-	-	-
8. Canning & Preserv.	-	-	-	-	-	.0008	-	-	.0008	.0003	-	-	-	-	-	-	-
9. Grain Mills	-	-	-	.1301	-	-	.0004	.0003	-	.0017	-	-	-	-	-	-	-
10. Bev. & Other Foods	-	-	-	.0061	-	.0004	.0026	.0241	.0136	-	-	-	-	-	-	.0004	-
11. Textiles & Apparel	.0027	.0019	-	-	-	.0050	-	-	-	-	-	.0005	-	.0012	-	-	-
12. Lumber & Wood	-	-	.0042	-	-	.0003	.0007	-	-	-	-	-	-	.0010	-	-	-
13. Plywood	-	-	-	-	-	-	-	-	-	-	-	.0047	-	.0010	-	-	-
14. Paper Products	.0006	.0019	.0031	-	.0058	-	.0082	.0221	.0016	.0312	.0034	.0006	.0014	-	.0454	.0013	.0025
15. Printing & Publish.	-	-	-	-	-	-	-	.0043	.0016	.0027	-	-	.0005	.0004	-	.0004	-
16. Chem. & Allied Prod.	.0275	.0304	.0127	.0076	.0144	.0023	.0007	.0005	-	.0015	.0011	.0016	.0074	.0238	-	-	.0025
17. Pet. & Pet Products	.0274	.0360	.0211	.0113	.0144	.0168	.0007	.0012	.0016	.0047	-	.0062	.0023	.0077	-	.0108	-
18. Stone, Clay, & Glass	-	.0019	.0015	.0029	-	.0004	.0007	.0036	-	.0176	-	.0002	-	.0002	-	.0004	-
19. Iron & Steel	.0006	-	-	-	-	-	-	-	-	-	-	.0002	-	.0002	-	.0009	-
20. Nonferrous Metals	-	-	-	-	-	-	-	-	-	-	-	-	-	.0007	-	-	-
21. Aluminum	.0019	.0038	-	-	-	-	-	-	-	-	-	.0002	-	.0009	-	.0009	-
22. Fabricated Metals	.0006	.0019	.0015	.0009	-	-	.0037	.0639	-	.1046	-	.0026	.0126	.0010	.0030	.0060	.0002
23. Machinery	.0006	.0019	-	-	-	.0027	-	-	-	.0003	-	.0036	.0014	.0110	-	.0004	-
24. Aerospace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25. Other Transportation	-	-	-	-	-	.0023	-	-	-	-	-	.0002	-	.0004	-	-	.0002
26. Other Manufacturing	-	-	-	-	-	-	.0002	-	-	-	.0122	.0005	.0009	.0005	.0006	.0004	-
27. Construction	.0062	.0056	.0042	.0038	.0029	.0004	.0009	.0010	.0008	.0007	-	.0019	.0018	.0020	.0006	.0018	.0063
28. Transp. Services	.0062	.0056	.0050	.0235	.0058	.0091	.0288	.0297	.0168	.0173	-	.0772	.0313	.0257	.0024	.0108	.0220
29. Communication	.0013	.0132	.0046	.0059	.0058	.0015	.0019	.0023	.0016	.0050	.0078	.0041	.0018	.0015	.0059	.0043	.0005
30. Elect. Services	.0090	.0057	.0050	.0046	.0058	.0012	.0015	.0018	.0016	.0015	.0056	.0068	.0032	.0108	.0024	.0307	.0046
31. Natural Gas Serv.	-	-	-	-	-	.0008	.0028	.0023	.0032	.0020	-	.0024	.0014	.0135	.0017	.0268	.0102
32. Water, San., & Irr.	.0105	.0057	.0054	.0059	.0058	-	.0011	.0023	-	.0017	.0011	-	.0005	.0012	.0006	.0030	.0022
33. Trade	.0150	.0151	.0161	.0269	.0201	.0046	.0168	.0374	.0120	.0180	.0033	.0185	.0196	.0206	.0047	.0013	.0005
34. Fin., Ins., & R.E.	.0118	.0152	.0065	.0067	.0058	.0046	.0047	.0038	.0040	.0059	.0045	.0102	.0070	.0062	.0095	.0052	.0100
35. Services	.0305	.0342	.0173	.0399	.0201	.0161	.0060	.0107	.0072	.0057	.0111	.0081	.0112	.0046	.0313	.0190	.0049
36. Value - Created	.7165	.6375	.7996	.3780	.7672	.8160	.2146	.3277	.1744	.5312	.4356	.5118	.3558	.5736	.6840	.5573	.3225

Table 7 (cont.)

Stone, Clay, & Glass	Iron & Steel	Nonferrous Metals	Aluminum	Fabricated Metals	Machinery	Aerospace	Other Transportation	Other Manufacturing	Construction	Transp. Services	Communication	Elect. Services	Natural Gas Serv.	Water, San., & Irr	Trade	Fin., Ins., & R.E.	Services	Washington Personal Consumption
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
-	-	-	-	-	-	-	-	-	-	-	-	-	-					
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	.0003	-	-	-	-	-	-	-	.0019
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.0044
-	-	-	-	-	-	-	-	-	.0007	-	-	-	-	.0018	-	-	-	.0014
.1149	.0023	.1051	-	-	-	-	-	-	.0085	-	-	-	-	-	-	-	-	.0013
-	-	-	-	-	-	-	-	.0036	-	.0045	-	-	-	-	.0029	-	.0025	.0312
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.0013	.0081
-	-	-	-	-	-	-	-	-	-	.0001	-	-	-	-	-	-	.0006	.0001
-	-	-	-	-	-	-	-	-	-	.0021	-	-	-	-	.0032	-	.0002	.0134
-	-	-	-	-	-	-	.0007	.0045	-	-	-	-	-	-	.0002	-	.0009	.0014
.0012	-	.0017	.0006	.0019	.0003	-	.0012	.0496	.0408	.0029	.0003	.0050	.0106	.0018	-	-	.0001	.0003
-	-	-	.0012	.0008	.0006	-	.0005	.0109	.0180	.0037	-	-	-	-	-	-	-	.0001
.0063	-	-	-	.0023	.0014	.0006	-	.0154	.0001	.0005	.0045	-	-	-	.0065	.0023	.0026	.0087
-	-	-	-	-	.0006	.0006	.0007	.0036	.0001	.0006	.0037	.0003	-	-	.0262	.0097	.0208	.0048
.0006	-	-	-	.0047	.0003	.0011	.0007	.0090	.0079	.0015	-	.0003	-	.0055	.0017	-	.0050	.0001
.0183	-	.0017	.0001	.0031	.0009	.0008	.0007	.0027	.0079	.0495	.0020	.0013	-	.0018	.0080	.0022	.0057	.0153
-	.0202	.0017	-	-	-	-	.0002	-	.0625	.0003	-	-	-	-	.0001	-	.0008	.0002
-	-	.0017	.0009	.0232	.0303	.0004	.0252	.0009	.0196	.0012	-	.0007	-	-	.0004	-	-	-
-	-	-	-	.0004	.0037	.0002	.0028	-	.0002	.0003	.0007	.0003	-	-	-	-	.0001	-
-	-	-	-	.0349	.0105	.0083	.0067	.0027	.0038	-	-	.0003	-	-	-	-	-	-
.0050	-	-	-	-	.0080	.0015	.0030	.0100	.0618	.0001	-	.0031	.0096	.0026	.0004	-	.0007	.0001
.0006	.0067	.0123	.0007	.0027	-	.0064	.0060	.0073	.0009	.0011	.0164	.0009	-	-	.0017	-	.0034	.0002
-	-	-	-	-	-	-	-	-	-	.0055	-	-	-	-	-	-	-	-
-	-	-	-	-	.0009	-	-	-	.0012	.0105	-	.0003	-	-	.0008	-	-	.0011
.0006	.0011	-	-	.0144	.0046	.0007	-	-	-	-	.0017	.0003	-	-	.0011	.0014	.0030	.0019
.0012	.0023	.0018	.0012	.0004	.0003	.0006	.0012	.0009	-	.0123	.0103	.0138	.0107	.0192	.0014	.0067	.0042	.0031
.0006	.0202	-	.0112	.0046	.0021	.0009	.0044	.0064	.0185	-	.0003	.0103	-	.0091	.0077	.0051	.0014	.0083
.0032	.0011	.0018	.0018	.0023	.0052	.0032	.0016	.0036	.0036	.0061	-	.0025	.0010	.0018	.0121	.0073	.0352	.0117
.0045	.0146	.0018	.0462	.0031	.0046	.0017	.0027	.0055	.0039	.0043	.0040	-	.0042	.0366	.0154	.0043	.0136	.0106
.0379	.0292	.0158	.0009	.0054	.0062	.0007	.0012	.0027	.0008	.0019	.0014	-	-	.0219	.0041	.0014	.0043	.0021
-	-	-	.0020	-	.0009	.0003	.0009	.0018	-	-	-	.0028	-	-	.0004	.0001	.0001	.0034
.0139	.0382	.0018	.0003	.0089	.0059	.0015	.0055	.0145	.0278	.0097	.0034	.0035	-	-	-	.0131	.0100	.1659
.0063	.0101	.0035	.0069	.0093	.0062	.0035	.0051	.0082	.0077	.0225	.0096	.0094	.0085	.0146	.0302	-	.0190	.0462
.0021	.0180	.0035	.0054	.0097	.0300	.0129	.0099	.0282	.0225	.0137	.0134	.0461	.0690	.0731	.0470	.0371	-	.0988
.6029	.6101	.2031	.3328	.4940	.5632	.4396	.5560	.5350	.3378	.6266	.8359	.7938	.4452	.5649	.7702	.8743	.6763	-

by dividing each cell in Table 5 by the total output in the purchasing sector. Entries in columns 1 through 35 measure purchases by industries in column headings from industries in row headings per dollar of total output of industries in column headings. Entries in column 36 measure personal consumption expenditures on goods produced by industries in row headings per dollar of value created.

Energy Sectors

Petroleum refining and related industries (sector 17), electrical companies and services (sector 30), and gas companies and services (sector 31) in Table 1 are what have been called "the energy sectors" in the input-output model of Washington. The importance of the energy sectors in the Washington economy can be explained by their relationship to other industries. Being resource sectors, they are related to other sectors directly and indirectly through interindustry flows. For example, the petroleum industry has sales to all other industries except to the textile and printing and publishing sectors. In 1967, the petroleum industry sold $410 million worth of its products to various industries and final demand sectors. The largest interindustry sales went to the transportation services industry. Sales to the household sector amounted to $177 million. The petroleum industry purchased $250.5 million worth of goods and services, about 60 percent of its total sales, from outside of the region. The imports included $44.2 million from other states in the United States and $206.3 million from foreign countries.

The electricity sector (30) and natural gas sector (31) showed their biggest interindustry sales to the trade sector (33). The electricity sector had its second largest interindustry sales to the aluminum industry (21) while the natural gas sector had its second largest sales to the paper and pulp sector (14).

The natural gas industry also relies on imports. It had imports of $41.5 million which amounts to 44 percent of total sales. Almost all of the gas imports came from other states in the United States rather than from foreign countries.

Impact of Price Changes

The empirical model was used to estimate the economic impact of changes in prices of the products of the three energy sectors. In each case, the price change is assumed to be exogeneously determined.

Electricity Sector

Electricity in Washington is mostly produced in hydroelectric plants within the state or at least within the Pacific Northwest regional system. An exogenous price change, in this sector is occuring due to the necessity of employing more expensive techniques of generation to meet power needs in excess of the hydro-system's capacity. Changes in pricing policy could also lead to a price change of an exogenous nature. The electricity sector is tied to the rest of the economy through both industrial and household sectors. The household's personal consumption coefficient is (column 36, row 30 in Table 2) .01067. Thus, when income increases by $1, Washington households buy about 1¢ more electricity. Conversely, when the price of electricity goes up by 1 percent, Washington residents decrease their purchases of electricity by about 1 percent.

Changes in Total Earned Income

Tables 3, 4, and 5 show the residual income, wage income, and total earned income in the Washington economy when the price of electricity is doubled while all other prices and final demands are held at 1967 levels. This effect is due to the fact that electricity is a basic resource input for all sectors so that increases in the price of electricity increase the costs of production for all sectors.

Table 3. Changes in residual income resulting from doubling electricity price and final demand

Sector	(1) Base year Residual Income (million $)	(2) Residual Income with Double electricity price (million $)	(3) Rate of Change in (2) Over (1) (million $)	(4) Residual Income with Double elec. Final demand (million $)	(5) Rate of Change in (4) Over (1) (million $)	(6) Residual Income with Double elec. Demand & price (million $)	(7) Rate of Change in (6) Over (1) (million)
1. Wheat	98.8	97.3	-1.5	98.8		97.4	-1.4
2. Other field and seed crops	28.3	28.0		28.3		28.1	
3. Vegetable, fruits and nuts	169.0	167.9		169.2		168.4	
4. Livestock & livestock products	73.1	72.5		73.4		73.2	
5. Other agricultural products	15.0	14.9		15.0		15.0	
6. Forestry, fishing & mining	170.2	170.0		170.4		170.3	
7. Meat & dairy products	50.9	50.5		51.1		51.0	
8. Canning & preserving	57.9	57.3	-1.0	58.0		57.5	
9. Grain mills	10.7	10.5	-1.8	10.7		10.5	-1.4
10. Beverages & other foods	156.1	156.0		156.5		156.9	
11. Textile products & apparel	14.3	13.8	-3.5	14.3		13.9	-3.2
12. Lumber & woods	86.9	82.4	-5.1	86.9		82.6	-5.0
13. Veneer & plywood	7.7	7.0	-9.0	7.7		7.0	-9.0
14. Paper & allied products	261.3	253.7	-2.9	261.6		254.3	-2.7
15. Printing & publishing	44.4	44.5		44.9		45.0	
16. Ind. chemicals & allied products	65.0	57.9	-10.9	65.0		58.0	-10.8
17. Petroleum & related industries	117.1	115.6	-1.2	117.5		116.5	
18. Glass, stone, cement & clay	53.6	52.1	-2.8	53.6		52.1	-2.8
19. Iron & steel	26.2	24.8	-5.3	26.2		24.9	-5.0
20. Nonferrous metal	4.0	3.9		4.0		3.9	-2.6
21. Aluminum	104.9	79.4	-24.3	104.9		79.4	-24.3
22. Fabricated metal products	62.1	61.3	-1.2	62.2		61.3	-1.0
23. Machine, equipment	68.8	67.3	-2.1	68.9		67.3	-2.1
24. Aerospace	171.5	167.3	-2.5	171.4		167.3	-2.4
25. Other transportation equipment	157.0	155.8		157.0		155.9	
26. Other manufacturing	14.5	13.9	-4.1	14.5		13.9	-3.8
27. Construction	221.1	212.7	-4.0	221.2		212.9	-3.9
28. Transportation services	107.4	103.9	-3.2	107.6		104.3	-3.0
29. Communications	103.7	103.0		131.5		131.4	
30. Electric systems and services	232.5	448.0	92.7	271.5	16.8	541.5	132.9
31. Gas systems & services	22.9	22.6	-1.3	22.9		22.7	
32. Water, sanitary & irrigation	23.6	21.7	-9.3	23.7		21.9	-7.2
33. Trade (wholesale & retail)	694.2	660.4	-4.9	697.6		667.4	-4.0
34. Finance, insurance & real estate	348.2	346.2		350.0		349.9	
35. Business & personal services	176.5	156.0	-11.6	177.6		158.0	-10.5
TOTAL	4,046.4	4,128.0	2.0	4,096.2	1.2	4,242.3	4.8

Blank spaces indicate less than one percent change.

Table 4. Changes in wage income resulting from doubling electricity price and final demand

Sector	(1) Base Wage income ~~with double elec. price~~ (million $)	(2) Wage income with double elec. ~~final demand~~ price (million $)	(3) Rate of Change in (2) Over (1) (million $)	(4) Wage income with double Elec. final Demand (million $)	(5) Rate of Change in (4) Over (1) (million $)	(6) Wate income with double elec. demand and price (million $)	(7) Rate of Change in (6) Over (1) (million $)
1. Wheat	16.2	16.2		16.2		16.2	
2. Other field & seed crops	5.3	5.3		5.3		5.3	
3. Vegetable, fruits & nuts	39.6	39.6		39.6		39.8	
4. Livestock & livestock products	17.0	17.1		17.1		17.2	1.2
5. Other agricultural products	11.7	11.7		11.7		11.8	
6. Forestry, fishing & mining	43.1	43.1		43.1		43.2	
7. Meat & dairy products	49.1	49.4		49.4		49.9	1.6
8. Canning & preserving	71.1	71.1		71.2		71.4	
9. Grain mills	11.1	11.1		11.1		11.1	
10. Beverages & other food	58.7	58.9		58.9		59.2	
11. Textile products & apparel	24.9	24.9		24.9		25.0	
12. Lumber & woods	242.9	242.8		243.0		243.1	
13. Veneer & plywood	68.4	68.3		68.4		68.4	
14. Paper & allied products	162.7	162.9		162.9		163.3	
15. Printing & publishing	71.4	71.6		71.6		72.4	1.4
16. Ind. chemicals & allied products	63.9	63.9		63.9		63.0	
17. Petroleum & related industries	15.1	15.1		15.1		15.2	
18. Glass, stone, cement & clay	41.9	41.9		41.9		41.9	
19. Iron & steel	28.1	28.0		28.1		28.1	
20. Nonferrous metal	7.6	7.6		7.6		7.6	
21. Aluminum	78.5	78.5		78.5		78.5	
22. Fabricated metal products	65.3	65.3		65.4		65.5	
23. Machine, equipment	113.5	113.5		113.6		113.6	
24. Aerospace	917.5	917.5		917.5		917.5	
25. Other transportation equipment	83.0	83.0		83.0		83.1	
26. Other manufacturing	44.4	44.4		44.5		44.6	
27. Construction	507.9	507.8		508.1		508.1	
28. Transportation services	398.7	399.0		400.0		400.2	
29. Communications	113.8	114.5		114.5		115.7	1.6
30. Electric systems & services	20.8	16.8	-19.2	24.2	16.3	20.4	-1.9
31. Gas systems & services	19.0	19.0		19.0		19.1	
32. Water, sanitary & irrigation	7.3	7.3		7.4		7.4	
33. Trade (wholesale & retail)	1,209.4	1,217.0		1,215.4		1,230.0	1.7
34. Finance, insurance & real estate	404.1	406.2		406.2		410.5	1.5
35. Business & personal services	876.0	890.3	1.6	882.0		891.5	1.8
TOTAL	5,909.0	5,921.8		5,930.2		5,960.6	

Blank spaces indicate less than 1 percent change.

Table 5. Changes in total earned income resulting from doubling electricity price and final demand

Sector	(1) Base year Earned Income (million $)	(2) Total income with double Elec. price (million $)	(3) Rate of Change in (2) Over (1) (million $)	(4) Total income with double Elec. final Demand (million $)	(5) Rate of Change in (4) Over (1) (million $)	(6) Total income with double Elec. demand and price (million $)	(7) Rate of Change in (6) Over (1) (million $)
1. Wheat	115.0	113.5	-1.3	115.0		113.6	-1.3
2. Other field and seed crops	33.6	33.3		33.6		33.4	
3. Vegetable, fruits & nuts	208.6	207.5		208.8		208.2	
4. Livestock & livestock products	90.1	89.6		90.5		90.4	
5. Other agricultural products	26.7	26.6		26.7		26.8	
6. Forestry, fishing & mining	213.3	213.1		213.5		213.5	
7. Meat & dairy products	100.0	99.9		100.5		100.9	
8. Canning & preserving	129.0	128.5		129.2		128.9	
9. Grain mills	21.8	21.6		21.8		21.6	
10. Beverages & other food	214.8	214.9		215.4		216.1	
11. Testile products & apparel	39.2	38.7	-1.2	39.2		38.9	
12. Lumber & woods	329.8	325.2	-1.4	329.9		325.7	-1.2
13. Veneer & plywood	76.1	75.3	-1.0	76.1		75.4	
14. Paper & allied products	424.0	416.6	-1.7	424.5		417.4	-1.5
15. Printing & publishing	115.8	116.1		116.5		117.4	1.3
16. Ind. chemicals & allied products	128.9	121.8	-5.5	128.9		129.0	
17. Petroleum & related industries	132.2	130.7	-1.1	132.6		131.7	
18. Glass, stone, cement & clay	95.5	94.0	-1.5	95.5		94.0	-1.5
19. Iron & steel	54.3	52.8	-2.7	54.3		53.0	-2.3
20. Nonferrous metal	11.6	11.5		11.6		11.5	
21. Aluminum	183.4	157.9	-13.9	183.4		157.9	-13.9
22. Fabricated metal products	127.4	126.6		127.6		127.0	
23. Machine, equipment	182.3	180.8		182.5		180.9	
24. Aerospace	1,089.0	1,084.8		1,088.9		1,084.8	
25. Other transportation equipment	240.0	238.8		240.0		239.0	
26. Other manufacturing	58.9	58.3	-1.0	59.0		58.5	
27. Construction	729.0	720.5	-1.1	729.3		721.0	-1.0
28. Transportation services	506.1	502.9		507.6		504.5	
29. Communications	244.5	244.5		245.9		247.1	1.0
30. Electric systems & services	253.3	464.8	83.5	295.7	16.7	561.9	121.8
31. Gas systems & services	41.9	41.6		41.9		41.8	
32. Water, sanitary & irrigation	30.9	29.0	-6.1	31.1		29.3	-5.2
33. Trade (wholesale & retail)	1,903.6	1,877.4	-1.3	1,913.0		1,897.4	
34. Finance, insurance & real estate	752.5	752.4		756.2		760.4	1.0
35. Business and personal services	1,052.5	1,046.3		1,059.4		1,049.5	
TOTAL Earned Income	9,955.4	10,049.8	.9	10,026.4		10,203.0	2.4
Autonomous Income	1,558.0	1,558.0		1,558.0		1,558.0	
Total Washington Income	11,513.4	11,607.8	.8	11,584.4		11,761.0	2.1

Table 3 shows that the electricity sector has a 92.7 percent increase in residual income when the price of electricity has doubled (from $232.5 to $448.0 million). On the other hand, the aluminium sector loses 24.3 percent of its residual income (from $104.9 to $79.4 million). The big loss of residual income by the aluminum sector is expected because this industry buys $.0462 worth of electricity directly for $1.00 worth of output. This is the biggest direct intermediate input purchase by the aluminium industry.

When the final demand for electricity has doubled, however, the impact is much different from doubling the price. As column (4) shows, no sector loses residual income, residual income in the electricity sector increases 16.8 percent to $271.5 million.

Changes in residual incomes due to changes in both price and final demand are shown in column (6) of Table 3. This column shows that while the electricity sector gains 132.9 percent in residual income, all other sectors either lose or have no gain at all.

Table 4 shows changes in wage income due to changes in price and final demand. The only significant change in wage income when the price of electricity has doubled is in the electricity sector where it shows a 19.2 percent decrease (from $20.8 to $16.8 million). The reason for a decrease in wage income in electricity when the price of electricity doubles is that the price increases have depressed houshold's demand for electricity while income increases were less than 1 percent (0.2 percent) and did not offset the price effects. Electricity sector and wage income increase 16.3 percent (to $24.2 million) when final demand is doubled.

Table 5 shows total earned income in the region. This table is nothing but a combination of Table 3 and 4 since total income is composed of residual income and wage income. Total earned income follows a similar pattern to residual incomes.

This is because the wage income was not significantly affected by the changes in price and final demand as Table 4 shows. Table 5 shows that while there is substantial increases in earned income in the electricity sector, all other sectors have faced either no increase in income or decreases in income. Thus doubling the price or final demand for electricity has a minimal net effect on Washington State's income.

Petroleum and Natural Gas Sectors

Washington's supplies of petroleum and natural gas are all imported from other states or from foreign countries. Therefore, supplies and prices affecting the regional economy are almost wholely determined by conditions outside of the region.

For the purpose of this study, only changes in prices are considered. We assess the impact of exogenously determined price increases at three levels: 20, 50, and 100 percent increases in the prices of petroleum and natural gas (sectors 17 and 31). The 20 percent increase in prices is more or less the average price increasé for both products during the 1960's. The 50 and 100 percent increases are more representative of current expectations.

In Table 6, three different residual incomes for each sector, corresponding to price increases of 20 percent, 50 percent, and 100 percent, are compared with the base year residual incomes. Each sector's change over the base year is also listed in columns 3, 5, and 7 respectively for 20, 50, and 100 percent increases.

Residual incomes in sectors 17 and 31 show increases as the rate of the price increase progresses. For example, when there is a 20 percent price increase, sector 17 has a 57.5 percent increases in residual income (from $117.1 to $184.5 million) but it increases to 253.1 percent when petroleum and gas prices go up 100 percent (from $117.1 to $413.5 million). Sector 31 shows a higher percentage increase than sector 17 under the same exogenous changes.

Table 6. Residual income due to changes in prices in petroleum and natural gas (in $ million).

	Residual Incomes			Percent change in income relative to base year		
Sector (1)	With 20% Price increase (2)	With 50% Price increase (3)	With 100% Price increase (4)	With 20% Price increase (5)	With 50% Price increase (6)	With 100% Price increase (7)
1	97.947	96.661	94.507			-4.34
2	27.891	27.403	26.509	-1.1	-2.8	-6.01
3	168.079	166.663	164.235		-1.4	-2.8
4	72.891	72.487	71.692			-1.86
5	14.928	14.836	14.664		-1.11	-2.19
6	169.457	168.179	166.023		-1.2	-2.42
7	50.808	50.613	50.204			-1.38
8	57.700	57.380	56.819			-1.9
9	10.594	10.431	10.152		-2.51	-5.1
10	155.942	155.585	154.867			
11	14.310	14.331	14.361			
12	85.792	84.124	81.343		-3.3	-6.34
13	7.539	7.300	6.901	-2.1	-5.19	-10.4
14	258.417	254.013	246.582	-1.1	-2.77	-5.77
15	44.743	44.909	45.120			1.17
16	63.259	60.666	56.344	-2.8	-6.64	-13.3
17	184.479	275.440	413.562	57.5	135.0	253.1
18	51.825	49.177	44.754	-3.31	-8.2	-16.57
19	25.686	24.912	23.592	-1.9	-5.0	-9.9
20	3.800	3.500	3.001	-5.0	-12.5	-25.0
21	104.783	104.605	104.308			
22	61.695	61.077	60.039		-1.68	-3.34
23	68.367	67.702	66.586		-1.62	-3.13
24	170.761	169.681	167.881		-1.06	-2.04
25	156.856	156.653	156.307		-.22	
26	14.393	14.240	13.977		-1.83	-3.34
27	217.380	211.818	202.550	-1.7	-4.1	-8.38
28	99.124	86.717	66.022	-7.7	-19.3	-38.6
29	131.155	131.525	131.973			
30	233.052	233.765	234.781			
31	39.899	63.903	101.920	74.2	179.0	345.0
32	23.419	23.074	22.631		-2.28	-4.01
33	69.132	686.158	676.364		-1.17	-2.64
34	348.879	349.644	350.525			
35	174.168	170.459	163.944	-1.3	-3.42	-7.1
TOTAL	4101.4	4169.6	4265.1	1.5	3.0	5.4

Blank spaces indicate less than 1% change.

There are a few sectors that show an increase in their residual incomes. For example, sector 11 has a slight increase (less than on percent). This sector buys neither petroleum nor natural gas as Table 1 indicates. Some other sectors have a slight increase in residual incomes due to the fact that they are either non-energy (petroleum and natural gas) consuming sectors or that they have very small direct and indirect requirements.

More than two-thirds of the 35 sectors show losses of residual incomes due to the price increases. Sectors whose residual income declined substantially are sectors 28 (Transportation), 20 (Nonferrous metals) and 19 (Iron and Steel). Sector 28's residual income declined 38.6 percent when the price of oil and gas doubled. Sector 20 lost 25 percent and sector 19 lost 9.9 percent. These three sectors are heavily dependent upon sectors 17 and 31 for their production inputs. For example, Table 2 shows that sector 28 buys about 5 cents from sector 17 in order to produce $1.00 worth of output. Sector 20 spends about a penny on sector 31 products for $1.00 worth of output.

Overall, income earned in the regional economy increases following the increases in prices. When the prices were doubled, the total earned income in the region increases 2.2 percent (from $9,955.4 million to $10,173.8 million). However, one particular feature of the price increases in oil and natural gas is that the increases in product prices would be mostly due to increased prices paid to exogenous suppliers. In that case, the gains in revenues due to a price increase would go out of the region as increased payments for imports and should not be included in regional earned income.[9] Thus, Table 7 shows changes in income

[9]Because outputs of sectors 17 and 31 are mostly imported, the "best" choice would be to specify exogenous changes in sectors 17 and 31 prices and commensurate changes in costs of production. However, the Washington Input-output model does not have import matrix from foreign countries so that the effects of changes in import prices can not be worked out. Therefore, in this study, a method of subtracting the gains in residual incomes in sectors 17 and 31 from total income is used. This approach is an approximate way of showing the "best" in the light of lack of import matrix for foreign goods and services.

Table 7. Changes in earned income due to changes in petroleum and natural gas import payments. (in $ million)

	Petroleum & natural gas price increases		
	20 %	50 %	100 %
(1)	(2)	(3)	(4)
Import payments			
Sector 17	67.4	158.3	296.5
Sector 31	17.0	41.0	79.0
Total	84.4	199.3	375.5
Earned income			
Less payments	9,930.0	9,879.0	9,798.3
Change from base year earned income (percent)	-.2	-.8	-1.6

due to increased payments for imports. When the price of petroleum and natural gas go up 20 percent, it is assumed that sectors 17 and 31 pay $84.4 million out to the exogenous industries supplying them. When the prices go up by 50 percent, the payments go up to $199.4 million and they jump to #375.5 million when prices double. Petroleum accounts for most of the payments.

Because the gains in residual income leave the economy as increased payments for imports, total regional income goes down as the import prices increase. Accordingly, all households consumption and output will also go down. Table 8 shows changes in output when prices of sector 17 and 31 output are doubled and, concurrently, income is decreased to allow for increased payments for imports. This table indicates that outputs in all other sectors would decline except in sectors 17 and 31. This is because of decreases in the total income and increases in the cost of petroleum and natural gas. However, value of output in sectors 17 and 31 increase because of the increases in value of output caused by price increases.

Summary

Table 9 is a summary of the empirical findings. In addition to results related to energy price and final demand changes, the table also presents selected results from varying price and final demand for the wheat sector's output. These estimates are included to provide contrast to results for the energy sector. Unlike the energy sectors, export demand accounts for the dominant share of total demand for wheat sector output. Only 2 industrial sectors used wheat as an input, and households demand was zero.

Results in Table 9 indicate that when the price of the wheat and electricity sectors are doubled separately, the residual income in the region increases to $4,224.3 million (4.4 percent increase) in the wheat case and to $4,127.8 million

Table 8. --Changes in output due to payments for imports

(1) Sector	(2) $84.4 mil Payment	(3) Rate of Change in (2) over the Base Year Output (Percent)	(4) $199.3 mil Payment	(5) Rate of Change in (4) over the Base Year Output (Percent)	(6) $375.4 mil Payment	(7) Rate of Change in (6) over the Base Year Output (Percent)
1	160.455		160.389		160.266	
2	52.575		52.385		52.035	-1.27
3	260.584	-.114	260.147		259.342	
4	237.320		235.714	-1.15	232.759	-2.37
5	34.651		34.490	-.78	34.195	-1.63
6	261.387		261.156		260.747	
7	463.948		460.792	-1.14	454.987	-2.38
8	393.136		392.320		390.818	
9	124.854		124.620		124.189	
10	403.490		402.084		399.496	-1.22
11	89.857		89.699		89.409	-.62
12	644.222		643.969		643.559	
13	213.838		213.800		213.738	
14	738.256		737.021		734.816	
15	168.495		167.310	-1.18	165.143	-2.46
16	231.069		230.817	-.19	230.424	
17	455.192	11.02	522.854	27.5	634.774	54.83
18	158.277		158.157		157.950	
19	88.971		88.928		88.855	
20	57.096		57.091		57.082	
21	551.084		551.063		551.029	
22	257.654		257.302		256.714	
23	323.622		323.470		323.195	
24	2477.489		2477.478		2477.461	
25	431.455		431.303		431.037	
26	109.854		109.597		109.126	
27	2157.602		2156.842		2155.665	
28	806.127		804.164		801.129	
29	291.487		289.610	-1.08	286.195	-2.3
30	217.870		316.143		313.126	-1.91
31	107.399	14.2	127.359	35.4	160.286	70.46
32	54.481		53.945	-1.59	53.295	-2.75
33	2459.904		2443.205	-1.15	2412.509	-2.34
34	856.320		850.561	-1.15	840.281	-2.29
35	1548.392		1536.891	-1.25	1516.165	-2.6

Blank spaces indicate less than 1% change.

Table 9. A summary table for empirical findings

Items	Base Year	Wheat Sector			Electricity Sector			Petroleum and Natural Gas Sector		
								Price Increases		
		Price has doubled	Final demand has doubled	Both price & final demand have doubled	Price has doubled	Final demand has doubled	Both price & final demand have doubled	20 percent	50 percent	100 percent
1. Residual income	4,046.4	4,224.3	4,170.2	4,525.9	4,127.8	4,096.2	4,242.3	4,101.4	4,169.6	4,265.1
2. Percent changes in residual income over base year		4.4	3.0	11.8	2.0	1.2	4.8	1.3	3.0	5.4
3. Wage income	5,909.0	5,957.2	5,971.2	6,067.9	5,921.8	5,921.8	5,930.2	5,919.9	5,934.7	5,956.7
4. Percent changes in wage income over base year		.8	1.0	2.7	.2	.3	.8	.1	.4	.8
5. Total earned income	9,955.4	10,181.6	10,141.4	10,593.8	10,049.8	10,026.4	10,203.0	10.021.3	10,104.3	10,221.8
6. Percent change in over the base year		2.2	1.8	6.4	.9	.7	2.7	.6	1.5	2.7
7. Payments for Imports								84.4	199.4	375.5
8. Net total earned income	9,955.4	10,181.6	10,141.4	10,593.8	10,049.8	10,026.4	10,203.0	9,936.9	9,904.9	9,846.3
9. Autonomous income	1,558.0	1,558.0	1,558.0	1,558.0	1,558.0	1,558.0	1,558.0	1,558.0	1,558.0	1,558.0
10. Total Regional income	11,513.4	11,739.6	11,699.4	12,151.8	11,607.8	11,584.4	11,761.0	11,494.9	11,462.9	11,404.3
11. Changes in output		Increased in all sectors	Increased in all sectors	Increased in all sectors	Increased in all but 12, 19,20,21,29 sectors	Increased in all sectors but 19	Increased in all sectors but 6,10,15, 29,34	Decreased in all sectors but 17,31	Decreased in all sectors but 17,31	Decreased in all sectors but 17,31
12. Sectors whose output increased most		7,15,33,35	32	32	4	35	32			
13. Sector residual income that lost most		4,9	24	4,9	16,21,35	24	35	18,19,20,28	16,18,19,20 27,28	19,20,28

(2.0 percent increase) in the electricity case. Thus, Washington state will be benefited by recent increases in the prices of wheat and electricity.

The table also shows that recent increases in the price of petroleum and natural gas will adversely affect the regional economy. When the prices are doubled, Washington state pays for $375.5 million worth of additional imports, consequently the region's total income will decline to $11,404.3 from the base year income of $11,513.4 million (1.0 percent decline).

Changes in output in each sector as the result of postulated exogenous changes vary in the wheat, electricity, and petroleum and natural gas cases. Changes in outputs are said to depend on: (1) final demand, (2) income effects, and (3) price effects.

In summary, the significance of these empirical findings is that they show how changes in exogenous variables, determined either by national economic policy or the international market situation, will affect the Washington economy.

Conclusions and Policy Implications

According to the export-base theory, the growth of any region is directly and indirectly tied to national economic policy and to national and international export markets. Thus, regional growth is dependent upon the expansion of the export-base in line with increases in the demand for the goods and services that the region can export. Results of this study suggest that wheat sector is an important export-base industry for the Washington economy. The total exogenous final demand for wheat takes about 90.2 percent of value of total sales by the endogenous wheat sector. About 80 percent of this sale is made to foreign countries. Assuming that both price and export-demand are simultaneously increased 100 percent, the residual income will increase sharply by almost 400 percent in the wheat sector.

The result of empirical study indicates that the electricity sector is not as strong as an export-base industry for two reasons. First, only $25.1 million worth of electricity was exported to other regions in 1967.

This is only 7 percent of the value of total sales made by the electricity sector and projected energy shortages in the next few years indicate little prospect for development of larger exports. Secondly, electricity is widely used as an input to other endogenous sectors of the region. Thus, higher priced electricity will adversely affect many industries' cost of production in Washington State and increases in the residual income in the electricity sector would be offset by decreases in the residual incomes of other sectors.

Changes in prices of final demand for individual sectors' output can have very dissimilar income distribution effects depending on the purchases and sales pattern of the individual sector. For example, when the price of wheat is doubled, only two sectors (livestock and livestock products sector and grain mills sector) are adversely affected and all the rest of the sector incomes increased. When the price of electricity is doubled, however, there is substantial increase in the residual income in the electricity sector but the remaining 34 sectors lose income. Decreases in residual incomes are also apparent when the price of petroleum and natural gas are increased.

An exogenous increase in petroleum and natural gas prices would increase costs and decrease real incomes in the region. If sectors using petroleum and natural gas products as inputs expect that the price increases in petroleum and natural gas products will be sustained, then they are likely to increase prices of their own products to cover the increases cost of production unless they are prevented from doing so by competition from markets where prices are not under similar pressure.

There are two implications that are directly related to the structure of the model in the Washington economy. First, the empirical results indicate that the multiplier effect when the final demands are doubled does not result in as

much income as doubling the price. Doubling the final demand will result in direct and indirect multiplier effects at the base year prices, while doubling the price will increase the value of output through similar multiplier effects as the final demand increases but at the new prices. But in addition, the price increase adds to income generated per unit of ouput in the sector where price has been doubled. This income generation more than compensates for income losses in sectors where unit costs for intermediate inputs have risen because of the price increase.

Secondly, in the input-output model with changing prices, the larger multipliers do not necessarily occur when there is a high degree of interdependency among the endogenous sectors as they do in conventional input-output models. For example, although only two sectors (livestock and livestock products and grain mills) are dependent upon the wheat sector and all 36 sectors are dependent upon the electricity sector. Changes in wheat price brough a greater multiplier effect on all three occasions than did changes in the price of electricity. This occurs because the regional benefits of a price increase are greatest when there are large sales outside of the region rather than internally. Thus, the income multipliers due to price effects tend to be associated with low interdependency and high exports.

BIBLIOGRAPHY

1. Berry, Brian J. L., Strategies, Models, and Economic Theories of Development in Rural Regions, U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 127, Washington, D.C., December, 1967.

2. Beyers, William E., Philip J. Bourque, Warren R. Seyfried, and Eldon E. Weeks, Input-Output Tables for the Washington Economy, 1967, Seattle, Washington, Graduate School of Business Administration, University of Washington, December, 1970.

3. Blakeslee, Leroy L., Eldon E. Weeks, Philip J. Bourque, William B. Beyers, and Warren R. Seyfreid, Wheat in the Washington Economy, An Input-Output Study, Pullman, Washington, College of Agriculture, Washington Agricultural Experiment Station, Washington State University, Bulletin No. 775, April, 1973.

4. Dorfman, Robert, Paul A. Samuelson, and Robert M. Solow, Linear Programming and Economic Analysis, New York, McGraw-Hill Book Company, 1958.

5. Lee, Chinkook, "The Effects of an Exogenous Change in Prices on a Regional Economy", Unpublished Ph.D. thesis, Wash. State Univ., 1974

6. Leontief, Wassily, The Structure of American Economy, 1919-1939, Second Edition, New York, Oxford University Press, 1951

7. Miernyk, William H., The Elements of Input-Output Analysis, New York, Random House, 1965.

8. Patinkin, Don, Money, Interest, and Prices, Second Edition, New Yor, Harper and Row, Publishers, 1965.

9. Perloff, Harvey S., Edgar S. Dunn, Jr., Eric E. Lampard, and Richard F. Muth, Regions, Resources and Economic Growth, Lincoln, Nebraska, University of Nebraska Press, 1966.

10. Quarterly Journal of Economics LI, (1930-37)

11. Stone, Richard, Mathematical Models of the Economy and Other Essays, London, Chapman and Hall, Ltd., 1970.

12. Yan, Chiou-Shuang, Introduction to Input-Output Economics, New York, Holt, Rinehart and Winston, 1969.

13. Walras, Leon, Elements of Pure Economics, Trans. W. Jaffe, Homewood, Ill., Richard Irwin, Inc. 1954.