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by

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Abstract

This paper explores the impact of the rapid energy price increases during the 1970's on beef production and prices in Hawaii by performing two simulations of a quarterly econometric model of the Hawaii beef industry. With energy prices increasing at pre-oil embargo rates, Hawaii could have produced 37 percent more grain-fed beef and 46 percent less grass-fed beef in 1980, for an increase in total beef production of 7 percent.

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Introduction

With the oil embargo in late 1973 and the continued influence of the Organization of Petroleum Exporting Countries (OPEC) came unprecedented increases in crude petroleum prices. Undoubtedly, many shifts occurred in American agriculture as relative input and product prices changed. An example is the search in the beef industry by both producers and researchers for less energy-intensive means of production. The hypothesis underlying this paper is that energy price increases during the 1970's significantly influenced both the composition and quantity of beef production in Hawaii. The major objective is to explore the impacts of the rapid energy price escalations of the 1970's on the Hawaii beef cattle industry.

Historical Production Trends

Historical trends in Hawaii beef production provide some indicators of how local producers might have responded to the rapid energy price increases of the 1970's. Between 1964 and 1973 Hawaii and the mainland United States maintained fairly constant shares of the Hawaii beef market, averaging 48 and 26 percent respectively. Figure 1 shows that Hawaii's competitive position with mainland imports began to erode in 1974, as Hawaii's share of the market dropped to 37 percent and the mainland's share rose to 42 percent. By 1975, Hawaii was producing only 31 percent of the beef consumed in the state, while 48 percent waw imported from the mainland. Hawaii's share increased to 36 percent in 1978, but again fell to 31 percent in 1980. By 1980, imports from the mainland accounted for 53 percent of the beef consumed in Hawaii, and

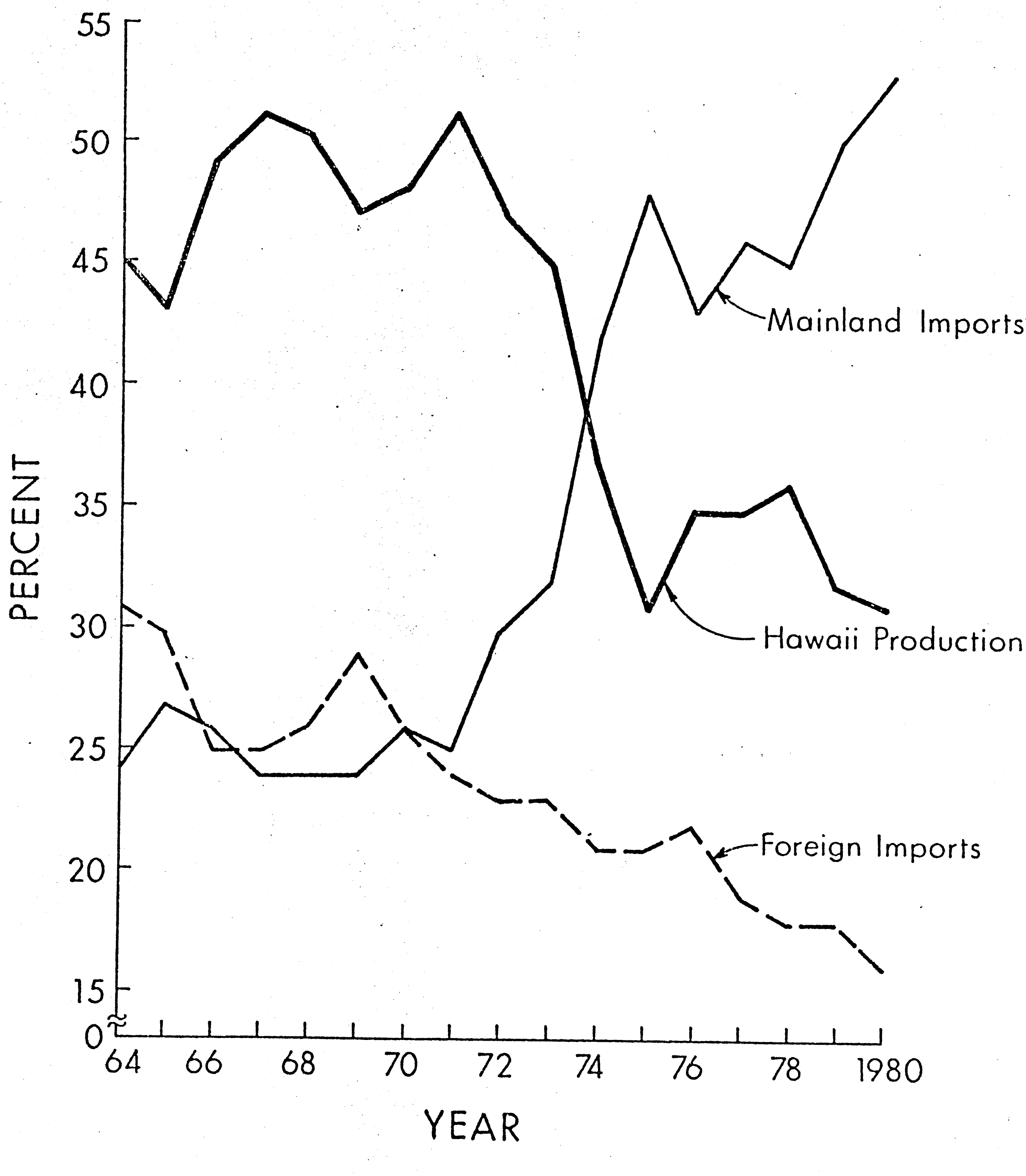

Figure 1. Percentages of Hawaii beef market supply contributed by Hawaii production, mainland imports, and foreign imports, 1964-80.

foreign beef imports dropped from 23 percent in 1973 to only 16 percent in 1980 (Hawaii Agricultural Reporting Service).

Figure 2 shows the dramatic changes in the composition of Hawaii beef production between 1969 and 1980. In 1969, 32 percent of the steer and heifer beef produced in Hawaii was grass-fed. The data demonstrate a definite downward trend to 1974 when only 17 percent of the steer and heifer beef was fed on grass. After 1974 the share of grass-fed steer and heifer beef trended upward to 32 percent in 1980 (Hawaiian Agricultural Reporting Service).

The contention of this paper is that rapidly increasing energy prices were a major cause of the trend reversals demonstrated in Figures 1 and 2. Of course, the authors recognize that there may have been other influences that contributed to changes in the structure of the Hawaii beef industry after 1973. For instance, the erosion of Hawaii's market share was probably influenced in a major way by physical constraints on beef production, as local supply was unable to keep pace with growth in population and tourist traffic. Also, higher relative feed costs, resulting from increases in U.S. grain prices, and shifts in consumer tastes toward leaner beef might have influenced the change in the composition of Hawaii beef production after 1973.

Against this background, an analysis of energy price impacts on the Hawaii beef industry is perfomed for the 1970's. A discussion is presented in the following pages of the various ways energy prices might influence Hawaii beef production. A quarterly econometric model of the Hawaii beef industry, which includes the influence of energy prices, is then presented. The model is used to perform two simulations from which the model is validated and the impacts of energy price increases are explored.

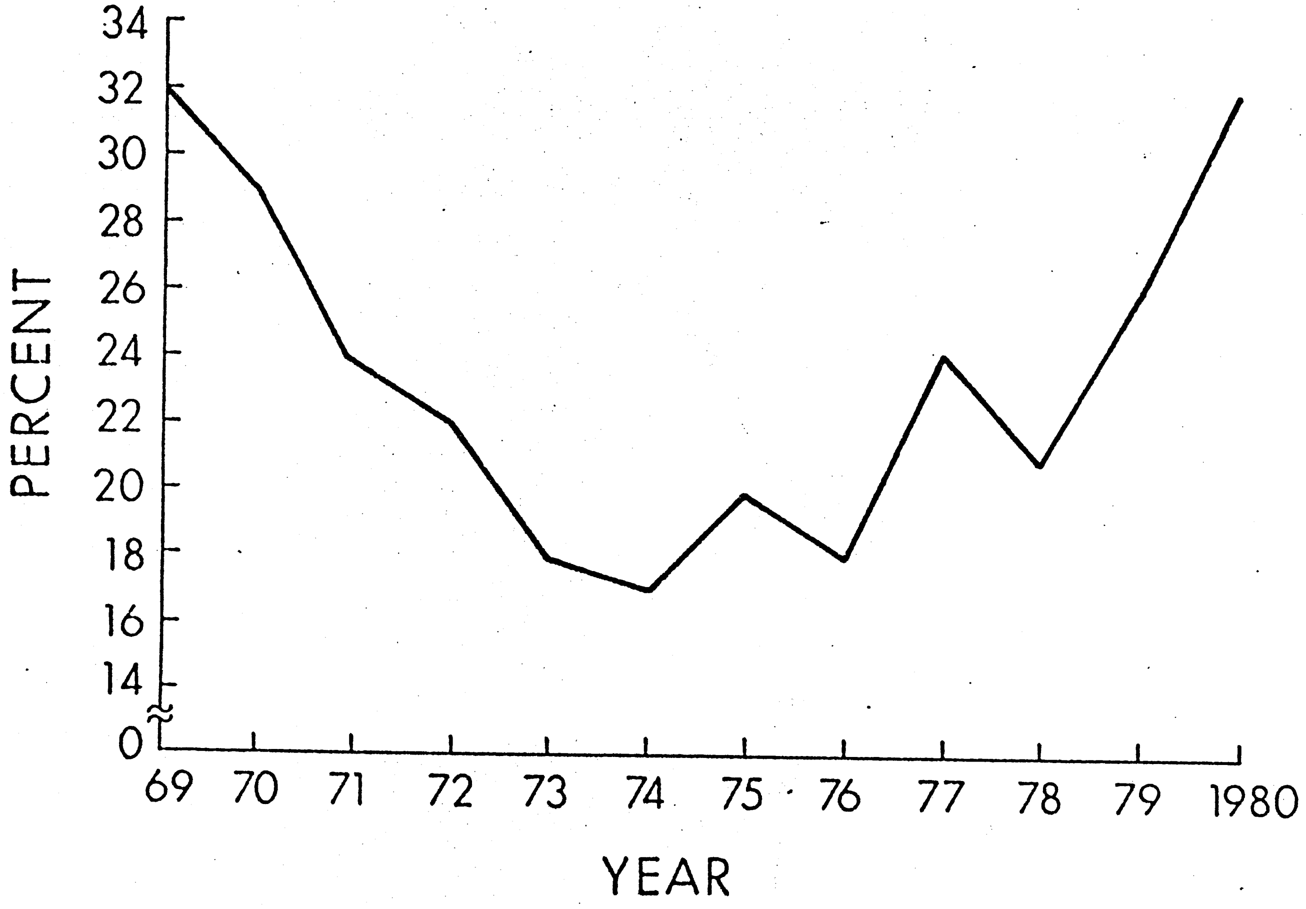

Figure 2. Hawaii range steer and heifer beef production as a percentage of total steer and heifer beef production, 1969-80.

Energy Prices and Hawaii Beef Production

Because of its isolation, the State of Hawaii provides a unique opportunity for examining the impacts of higher energy prices on beef production. The majority of beef consumed in Hawaii is imported from the U.S. mainland or from Australia and New Zealand, with transportation being a major cost. Virtually all of the grain used in Hawaii is imported from mainland sources and shipments of live animals in and out of Hawaii are insignificant. In 1980, the Hawaii Agricultural Reporting Service reported live cattle in-shipments of less than 50 head. The gap between local beef production and consumption is filled with imports of beef products rather than live animals, and freight rates for beef and grain are readily available.

Changes in energy prices affect the Hawaii beef industry in six major ways. First, the prices ranchers receive are directly related to transportation costs. Most of the beef consumed in Hawaii is imported from distant locations and competes directly with locally produced beef. Consequently, base point pricing is prevalent. For example, the choice steer price in Hawaii is approximately equal to the Los Angeles choice steer price plus the cost of transporting beef to Hawaii.

Second, transportation costs are important in determining feed concentrate and roughage costs because most feeds are imported from the U.S. mainland. Some feeds, mostly roughages in the form of pineapple bran, corn silage, hay, pineapple green chop, and the like, are produced locally but again transportation is a significant cost due to interisland freight charges and hauling to and from the docks and feedlots.

Third, most other beef production inputs are imported and thus are related to transportation costs. This is especially true for inputs used to produce grain-fed beef because less locally produced range and pasture is used relative to other inputs.

Fourth, trucking and interisland freight costs are important in determining the composition of beef production. The vast majority of grain-fed beef is produced in one feedlot, which is close to grain storage facilities and the state's major population center and harbor on Oahu. But, only about 5 percent of all cattle slaughtered originate on Oahu, and most of them are cull dairy cows. Grass-fed steers and heifers are traditionally slaughtered to supply the local market on the island where they are produced. However, in 1980 approximately 20 percent of the grass-fed steers and heifers produced in Hawaii were shipped as carcasses from the outer islands to Oahu. Given perfect markets, theory suggests that the prices received by ranchers on the outer islands would be the Oahu price minus transportation costs. Accordingly, increases in energy-related transportation costs would either be reflected in the higher cost of transporting feeder animals to Oahu or in a lower price received by ranchers for grass-fed animals as meat packers pass on to ranchers the higher cost of transporting slaughtered beef to Oahu. However, the shipment of processed beef both to and from the outer islands and differences in the preferences among the island populations for yellow fat suggest that the grass-fed beef market is not perfect. Grass-fed beef competes more favorably with grain-fed beef on islands other than Oahu because fat color is less important. In addition, the cost of transporting feeders to Oahu is an out-of-pocket cost, tied closely to changes in energy prices. On the other hand, energy-related decreases in returns for grass-fed beef might not be perceived by ranchers as a cost until the animals are sold several months later. Even then ranchers might not associate the decrease in returns with higher energy costs. Thus, imperfect knowledge and other market imperfections might lead to an actual and/or perceived avoidance of higher energy-related interisland transportation costs.

Fifth, since transportation costs influence most commodity prices in Hawaii, higher energy prices probably influence ranchers' expectations of the future cost and return structure of beef production. For instance, higher energy prices might cause ranchers to expect feed costs to increase in the future. This expectation would be in addition to expectations of future feed costs formed when assuming a constant energy price. Thus, higher energy prices might cause ranchers to leave more steers and heifers on grass because costs are less directly influenced by energy prices, at least in the short term.

Expectations formed from higher current energy prices also play a part in the cost of transporting feeder animals to Oahu because of the risk associated with shrinkage during transport. It takes 4 to 6 weeks for feeder cattle to regain their pre-shipment weight in the feedlot (College of Tropical Agriculture and Human Resources). Higher energy prices increase the expected cost of shrinkage because feed costs are expected to be higher, and therefore the expected loss associated with regaining body weight is expected to be higher.

Sixth, not only do energy prices directly affect Hawaii beef production through transportation costs but also indireetly through the mainland prices themselves. Mainland prices are determined by the structure of the national beef and feed industries. Changes in energy prices that cause changes in national supply and demand conditions, and consequently changes in mainland prices, also influence the Hawaii beef industry.

Model Structure

The econometric model estimated for this analysis is presented in Table 1 and variable and symbol definitions are given in Table 2. Priority in

Table 1. Estimated Equations and Identities of the Hawaii Beef Econometric Model

Equation Number	Equation
	I. Quarterly Freight Cost and Price Transmisson Equations
1	$TRANB_t = \underset{(.070)^a}{2.610} + \underset{(.0004)}{.0020ILP_t} + \underset{(.005)}{.027TIME}$, $R^{2b} = .9926$, $DW^c = 1.479$, ALS, $\hat{\rho} = \underset{(.094)}{.784}$.
2	$TRANC_t = \underset{(.612)}{14.385} + \underset{(.005)}{.0180ILP_t} + \underset{(.052)}{.394TIME}$, $R^2 = .9879$, $DW = 1.756$, ALS, $\hat{\rho} = \underset{(.120)}{.607}$.
3	$TRANCM_t = .25TRANC_t + .5TRANC_{t-1} + .25TRANC_{t-2}$
4	$WPFC_t = \underset{(1.477)}{-6.831} + \underset{(.020)}{.980USWPFC_t} + \underset{(.782)}{4.548TRANB_t}$, $R^2 = .9964$, $DW = 1.676$, OLS.
5	$WPRC_t = \underset{(3.584)}{-4.770} + \underset{(.051)}{.362USWPFC_t} + \underset{(.056)}{.262USWPFC_{t-1}} + \underset{(1.965)}{4.343TRANB_t} + \underset{(.640)}{1.573D1} + \underset{(.713)}{1.518D2} + \underset{(.601)}{.041D3}$, $R^2 = .9882$, $DW = 1.616$, ALS, $\hat{\rho} = \underset{(.129)}{.516}$.
6	$WPC_t = \underset{(3.577)}{-14.725} + \underset{(.064)}{.227USWPC_t} + \underset{(.076)}{.412USWPC_{t-1}} + \underset{(.075)}{.175USWPC_{t-2}} + \underset{(.070)}{.131USWPC_{t-3}} + \underset{(1.702)}{5.120TRANB_t}$, $R^2 = .9870$, $DW = 1.879$, ALS, $\hat{\rho} = \underset{(.137)}{.425}$.
7	$PCF_t = \underset{(.299)}{.535} + \underset{(.140)}{1.686USCPM_t} + \underset{(.012)}{.145TRANCM_t}$, $R^2 = .9747$, $DW = 1.728$, ALS, $\hat{\rho} = \underset{(.144)}{.360}$.
8	$CFD_t = PCF_t/10.56$
	II. Annual Inventory and Calf Crop Equations
9	$CBI_L = \underset{(25.386)}{8.754} + \underset{(.047)}{.114WPFC_{L-1}}/CFD_{L-1} - \underset{(.010)}{.0130ILP_{L-1}}/CFD_{L-1} + \underset{(.242)}{.784CBI_{L-1}}$, $R^2 = .8561$, $DH = -.583$, OLS.
10	$HI_L = \underset{(8.500)}{-10.528} + \underset{(.087)}{.449CC_{L-1}} - \underset{(.015)}{.623WPFC_{L-1}}/CFD_{L-1} + \underset{(.003)}{.1500ILP_{L-1}}/CFD_{L-1} + \underset{(.094)}{.532HI_{L-1}}$, $R^2 = .8278$, $DH = -.922$, ALS, $\hat{\rho} = \underset{(.253)}{-.568}$.
11	$HOI_L = \underset{(3.106)}{-5.734} + \underset{(.070)}{.828}(HI_L - HDI_L) + \underset{(.009)}{.0008WPFC_{L-1}}/CFD_{L-1} - \underset{(.001)}{.0120ILP_{L-1}}/CFD_{L-1}$, $R^2 = .9660$, $DW = 2.630$, ALS, $\hat{\rho} = \underset{(.261)}{-.499}$.
12	$HBI_L = HI_L - HOI_L - HDI_L$.
13	$SI_L = \underset{(8.035)}{-18.682} + \underset{(.115)}{.540CC_{L-1}} - \underset{(.020)}{.050WPFC_{L-1}}/CFD_{L-1} + \underset{(.108)}{.496SI_{L-1}}$, $R^2 = .8670$, $DH = -1.184$, ALS, $\hat{\rho} = \underset{(.246)}{-.604}$.
14	$CC_L = \underset{(24.931)}{-34.757} + \underset{(.183)}{.899}(CBI_L + CDI_L) + \underset{(.375)}{.784}(HBI_L + HDI_L)$, $R^2 = .7275$, $DW = 2.216$, ALS, $\hat{\rho} = \underset{(.273)}{-.426}$.
	III. Quarterly Slaughter Equations
15	$FCS_t = \underset{(1762.3)}{-4233.5} - \underset{(23.447)}{51.732TSHOIQ_t*D1} - \underset{(16.149)}{57.63TSHOIQ_t*D2} - \underset{(14.233)}{1.809TSHOIQ_t*D3} + \underset{(22.84)}{103.5TSHOIQ_t} + \underset{(20.727)}{44.402TSHOIQ_{t-4}*D1} + \underset{(507.72)}{221.42RSHOIQ_t*D1}$ $+ \underset{(537.33)}{1489.1RSHOIQ_t*D2} + \underset{(484.35)}{31.939RSHOIQ_t*D3} + \underset{(905.65)}{2104.4RSHOIQ_t} + \underset{(11.96)}{37.9WPFC_{t-1}}/CFD_{t-1} - \underset{(16.516)}{39.359WPRC_{t-1}}/CFD_{t-1} - \underset{(1.634)}{3.741OILP_{t-1}}/CFD_{t-1}$ $- \underset{(6.273)}{18.067}(WPFC_{t-1}/CFD_{t-1} - WPFC_{t-2}/CFD_{t-2}) + \underset{(2.549)}{8.816}(OILP_{t-1}/CFD_{t-1} - OILP_{t-2}/CFD_{t-2}) + \underset{(207.38)}{972.86DUM1} + \underset{(195.4)}{593.36DUM2} - \underset{(232.25)}{253.64DUM3}$ $- \underset{(136.11)}{372.88W_t} + \underset{(17.248)}{27.93TIME}$, $R^2 = .9485$, $DW = 1.861$, ALS, $\hat{\rho} = \underset{(.132)}{.563}$.
16	$RCS_t = \underset{(216.44)}{421.65} + \underset{(4.778)}{4.819WPRC_{t-2}}/CFD_{t-2} - \underset{(3.051)}{6.784WPFC_{t-2}}/CFD_{t-2} + \underset{(.469)}{.758OILP_{t-2}}/CFD_{t-2} - \underset{(3.786)}{5.914TIME} + \underset{(76.171)}{183.14DUM3} - \underset{(52.237)}{5.317D1} + \underset{(46.706)}{177.38D2}$ $+ \underset{(52.57)}{71.284D3} + \underset{(.069)}{.84RCS_{t-1}}$, $R^2 = .8776$, $DH = -.427$, ALS, $\hat{\rho} = \underset{(.157)}{-.225}$.
17	$TFRCS_t = FCS_t + RCS_t$.
18	$CS_t = \underset{(848.1)}{3024.6} - \underset{(.409)}{.742CIQ_t*D1} + \underset{(.438)}{.955CIQ_t*D2} + \underset{(.374)}{.418CIQ_t*D3} - \underset{(8.035)}{14.244CIQ_t} + \underset{(3.659)}{10.096}(WPC_t/CFD_t - WPC_{t-1}/CFD_{t-1}) - \underset{(2.017)}{5.161}(WPFC_t/CFD_t$ $- WPFC_{t-1}/CFD_{t-1}) - \underset{(2.725)}{7.972TIME} + \underset{(42.543)}{105.38W_t}$, $R^2 = .6723$, $DW = 1.920$, ALS, $\hat{\rho} = \underset{(.141)}{.354}$.
19	$BS_t = \underset{(64.834)}{37.452} + \underset{(.038)}{.045CS_t} + \underset{(15.87)}{44.819D1} + \underset{(15.923)}{21.158D2} + \underset{(15.304)}{31.37D3} + \underset{(.142)}{.46BS_{t-1}}$, $R^2 = .3178$, $DW = 2.058$, OLS.
20	$TBEEFS_t = TFRCS_t + CS_t + BS_t$.
	IV. Period Transition Identities
21	$CFD_L = .25(CFD_t + CFD_{t+1} + CFD_{t+2} + CFD_{t+3})$.
22	$WPFC_L = .25(WPFC_t + WPFC_{t+1} + WPFC_{t+2} + WPFC_{t+3})$.
23	$OILP_L = .25(OILP_t + OILP_{t+1} + OILP_{t+2} + OILP_{t+3})$.
24	$CIQ_t = CBI_L + CDI_L$, $t = L*4-3$ through $L*4$.
25	$TSHOIQ_t = SI_L + HOI_L$, $t = L*4-3$ through $L*4$.
26	$RSHOIQ_t = SI_L/HOI_L$, $t = L*4-3$ through $L*4$.

[a] Numbers in parentheses are standard errors.

[b] R^2 in ALS equations is calculated by subtracting the ratio of the sum of squares residual to the total sum of squares from one. It is used only as a measure of goodness-of-fit.

[c] DW and DH are calculated from the residual of ALS equations after correcting for autocorrelation.

Table 2. Variable and Symbol Definitions[a]

Variable or Symbol	Definition
	Endogenous Variables
BS	Dressed weight bull slaughter (1000 pounds).
CBI	January 1 beef cow inventory (1000 head).
CC	Annual calf crop (1000 head).
CFD	Index of Hawaii cattle feed price (1980 = 1.0).
CIQ	January 1 beef plus dairy cow inventory for each quarter of the current year (1000 head).
CS	Dressed weight cow slaughter (1000 pounds).
FCS	Dressed weight feedlot steer and heifer slaughter (1000 pounds).
HBI	January 1 inventory of heifers held for beef cow replacement (1000 head).
HI	January 1 heifer inventory (1000 head).
HOI	January 1 inventory of heifers not held for beef or dairy cow replacement (1000 head).
PCF	Price paid by ranchers for cattle feed in Hawaii (dollars/ton).
RCS	Dressed weight range steer and heifer slaughter (1000 pounds).
RSHOIQ	Ratio of January 1 inventory of steers to January 1 inventory of heifers not held for replacement, for each quarter of the current year.
SI	January 1 steer inventory (1000 head).
TBEEFS	Total beef production in Hawaii (1000 pounds).
TFRCS	Total dressed weight steer and heifer slaughter (1000 pounds).
TRANB	Cost of transporting boxed beef from the U.S. West Coast to Hawaii in Matson Navigation Company containers (dollars/100 pounds).
TRANC	Cost of transporting animal feeds and feed ingredients from the U.S. West Coast to Hawaii in Matson Navigation Company containers (dollars/ton).
TRANCM	Three-year-weighted-moving-average of TRANC. The weights are 1/4, 1/2, and 1/4.
TSHOIQ	January 1 inventory of steers plus January 1 inventory of heifers not held for replacement for each quarter of the current year (1000 head).
WPC	Honolulu wholesale price for cow carcasses (dollars/100 pounds).
WPFC	Honolulu wholesale price for choice steer and heifer carcasses (dollars/100 pounds).
WPRC	Hawaii dressed weight price for range steers and heifers (dollars/100 pounds).
	Exogenous Variables
CDI	January 1 dairy cow inventory (1000 head).
D1	Equals 1 in the first quarter and 0 otherwise.
D2	Equals 1 in the second quarter and 0 otherwise.
D3	Equals 1 in the third quarter and 0 otherwise.
DUM1	Equals 1 in the second and third quarters of 1973 and 0 otherwise.
DUM2	Equals 1 from the first quarter of 1976 through the second quarter of 1977 and 0 otherwise.
DUM3	Equals 1 from the last quarter of 1978 through the last quarter of 1980 and 0 otherwise.
HDI	January 1 inventory of heifers held for dairy cow replacement (1000 head).
OILP	U.S. crude petroleum wholesale price index (1967 = 100.0).
TIME	Equals 1 in the first quarter of 1970, 2 in the second quarter of 1970 to 44 in the last quarter of 1980.
USCPM	Three-year-weighted-moving-average of the average price received by U.S. farmers for corn (dollars/bushel). Same weights as for TRANCM.
USWPC	Los Angeles wholesale carcass price of utility cows (dollars/100 pounds).
USWPFC	Los Angeles wholesale carcass price of choice steers (dollars/100 pounds).
W	Equals 1 in quarters when droughts occurred and 0 otherwise.
	Other Symbols
R^2	One minus the ratio of the sum of squares residual to the sum of squares total.
DW	Durbin-Watson statistic.
DH	Durbin H statistic.
OLS	Ordinary least squares.
ALS	Autoregressive least squares.
$\hat{\rho}$	Estimated first order autoregressive parameter.
t	Refers to the current quarter.
L	Refers to the current year.

[a]The data were obtained from the following sources: Hawaii Agricultural Reporting Service, Statistics of Hawaiian Agriculture, and worksheets; Hawaii Market News Service, Honolulu Prices: Wholesale Eggs, Poultry, Pork, Beef and Rice; U.S. Department of Commerce, Business Statistics, 1977, and Survey of Current Business; Matson Navigation Company, Tariffs 14-B through 14-G; U.S. Department of Agriculture, Agricultural Prices, Annual Summary; California Federal-State Market News Service, Livestock and Meat Prices and Receipts at Certain California and Western Area Markets; National Weather Service, Honolulu, Hawaii, worksheets from Saul Price, Staff Meterologist.

structure estimation was given to goodness-of-fit and to special characteristics of the Hawaii beef industry, given the available data. For example, because of inadequate data on mainland imports, the model includes no market clearing identity requiring the quantities supplied and demanded to be equal.

A characteristic of the Hawaii beef industry which greatly simplifies estimation procedures is that all prices are determined exogenously. Consequently, the model exhibits no simultaneity and it is assumed that the industry can be represented by a recursive model structure. Ordinary least squares and autoregressive least squares estimation methods were used to estimate the structural equations of the model. Two different autoregressive least squares techniques were employed, depending upon whether or not geometric distributed lags were assumed (White). For those equations estimated as distributed lags, partial adjustment was assumed (Nerlove). Each equation was estimated with autoregressive least squares and ordinary least squares. If the estimated autoregressive parameter was significantly different from zero at the 5 percent level, the autoregressive least squares equation was retained for use in the model. In some cases, if model validation results were improved, an autoregressive least squares equation with an insignificant autoregressive parameter was retained over on. ordinary least squares equation. The quarterly equations were estimated with data for the first quarter of 1970 through the last quarter of 1980 and the annual inventory equations used observations for 1970 through 1981. The sample period for the annual calf crop equation was 1970 through 1980.

Table 1 presents the structural equations and identities of the model in four sections. Section I consists of two equations determining mainland-to-Hawaii transportation costs, four price transmission equations and two identities. In equations 1 and 2, the U.S. crude petroleum wholesale price index (OILP) is used to represent the influence of energy prices on transportation costs. The time trend is a proxy for a combination of other variables that might cause freight rates to change over time. Equation 3 simply forms a weighted-moving-average of the cost of transporting feed to Hawaii. It is later used in equation 7.

In equations 4-6, energy prices influence Hawaii beef prices through transportation costs. The formulation of equation 4 is rather straightforward. Since most of the grain-fed beef consumed in Hawaii is imported from the mainland, the price in Hawaii should theoretically be the mainland price plus freight costs. Actual practice follows this formula quite closely. Once a week the major Hawaii packing plants call Los Angeles for price quotations. Hawaii prices of steers and heifers are based on these quotations plus a markup for freight costs.

The specifications of equations 5 and 6 are not so obvious because foreign imports of cow and grass-fed steer and heifer beef distort the relationship. Most of the unprocessed lower quality beef imported into the State comes from Australia and New Zealand, while almost none comes from the mainland United States. Therefore, Hawaii range and cow beef production competes more directly with foreign imports than with mainland imports. In the absence of beef import quotas and mainland imports of processed low quality beef products, theory suggests that the cow price in Hawaii would be the price in Australia and New Zealand plus freight costs. The U.S. mainland also imports large quantities of Australian and New Zealand beef, and again in the absence of import quotas, theory suggests that the mainland cow price would be the Australian and New Zealand price plus freight costs. This logic implies that changes in the Australian and New Zealnd cow prices are reflected in both the mainland and Hawaii cow prices. If freight costs are the same to Hawaii or the mainland from Australia and New Zealand, the Hawaii cow price should equal the mainland cow price. Through this reasoning, the need to use foreign prices is eliminated because their influence is captured in the mainland price. Given equal freight costs, the equality of mainland and Hawaii cow prices also holds when beef import quotas are imposed. Because the beef import quota does not differentiate between U.S. ports, any price differential would soon be eliminated as Australian and New Zealand exporters seek to market their quota beef in the U.S. ports where the highest return can be realized.

In determining the Hawaii cow price and the range steer and heifer price, three additional points must be considered. First, even though little if any cow and grass-fed unprocessed beef is imported from the mainland, large unspecified quantities of lower quality processed beef are imported in the form of hamburger, and the like, by fast food and other enterprises. This also competes with locally-produced range and cow beef. Second, a significant portion of the lower quality processed beef from the mainland probably originates in Australia and New Zealand. Therefore, equations 5 and 6 include the freight cost variable. Third, lagged prices in equations 5 and 6 are included to reflect delays in price transmission caused by the great distances involved and by pricing practices of local packing plants which are less obvious than the pricing of grain-fed beef.

Equation 7 expresses the price of cattle feed in Hawaii as a function of the moving averages of the U.S. average corn price (USCPM) and the cost of freight (TRANCM). Moving averages were used to avoid multicollinearity problems. Equation 8 simply converts the Hawaii cattle feed price into an index with 1980 equal to 1.0. This index is used as a deflator for all prices in the remainder of the model. A preferred index would have been an index of prices paid by farmers for production inputs in Hawaii but such an