

3105
E55
no. 178
op. 2

Beef Imports and the U.S. Beef Cattle Market

SPECIAL REPORT 178

Agricultural Experiment Station
Oregon State University
Corvallis



SUMMARY

1. The estimated effect of imports on the average price received by U.S. farmers for beef cattle depends upon the assumptions which are made concerning the conditions which gave rise to the import situation.
 - a. If it is assumed that the increase in the volume of imports during the 1958-62 period was due entirely to overproduction at the import source, an increase of one pound per capita on the quantity of beef imported is estimated to result in a reduction in U.S. farm price of \$0.41 per cwt.;
 - b. If it is assumed that imports occur only when domestic supplies of equivalent-grade beef are less than those which the domestic market can absorb without an increase in price, an increase in imports is not necessarily price-depressing.
2. While no attempt is made to appraise the merits of enacting quotas on U.S. beef imports, it is suggested that if a quota program were to be established a variable quota would be more desirable than a fixed quota. A method for establishing such a quota is outlined.

Author: John A. Edwards is Assistant Professor of Agricultural Economics at Oregon State University.

BEEF IMPORTS AND THE U.S. BEEF CATTLE MARKET

by

John A. Edwards

This report is concerned with estimating the effects of beef imports upon domestic cattle prices. Prior to 1958, imports into the United States of both beef animals and meat averaged about 204 million pounds annually, an amount approximately 2.8% of domestic beef and veal production. ^{1/} During the period 1958-62, imports of beef have averaged 1,028 million pounds annually--equal to approximately 7.3% of domestic production. In 1963, preliminary estimates place imports at 1,679 million pounds and domestic production of beef and veal at 16,896 million pounds.

Recent price developments in the U.S. cattle market have stimulated interest on the part of cattle producers in the effect which this increased volume of imports is exerting on the domestic market. In 1958, the average price of U.S. choice slaughter steers at Chicago was \$27.43 per cwt. ^{2/}; in 1963 the average price was \$23.96 per cwt. and in January 1964 had declined to \$22.61 per cwt. This decline, it must be emphasized, occurred entirely in 1963, the average 1962 price being \$27.67 per cwt. In contrast, the average price of utility cows at Chicago declined continuously from the 1958 level of \$18.41 per cwt. to \$13.19 per cwt. in January 1964.

While controversy may exist regarding the role which increased imports have played in these price developments, it is important to recognize the fundamental change which took place in the world cattle and meat markets in 1958 creating the environment in which these events have taken place.

Prior to 1958, the domestic U.S. cattle and beef markets were protected markets. Although regulations governing the import of diseased animals and products from such animals were restrictive to some extent, the primary instrument protecting the U.S. producer from foreign competition was the

^{1/} These figures are based on averages for the 1932-41, 1948-57 period derived from data reported in Livestock and Meat Statistics, 1957, Stat. Bul. No. 230, A.M.S., U.S.D.A., July 1958, p. 285; and Livestock and Meat Statistics, 1962, Stat. Bul. No. 333, A.M.S., U.S.D.A., July 1963, p. 290.

^{2/} Price data are reported in November 1963 and March 1964 issues of the Livestock and Meat Situation, E.R.S. U.S.D.A., pp. 42 and 30, respectively.

existence of the United Kingdom-Australian Meat Agreement which restricted the export of Australian meats, in more than token quantities, to countries other than the United Kingdom. Modification of this agreement in late 1958 permitted greater latitude to the Australian industry in finding overseas markets for its products; i.e., it eliminated the indirect protection from foreign competition heretofore enjoyed by the U.S. industry. In a very real sense, the U.S. market was changed from a relatively protected to an unprotected status in 1958. Since the barriers to entry in the U.S. market are almost nonexistent in comparison to those protecting other potential markets, the U.S. has been the major recipient of exports from Australia under this changed market situation. 3/

While the world market has become more competitive on the supply side, it has become less competitive on the demand side. In addition to the efforts of the United Kingdom to stimulate livestock production at home--a major reason for the 1958 modification of the Australian agreement--the nations of continental western Europe have maintained and, in many cases, increased the trade barriers protecting their domestic markets.

Domestically these developments may have influenced the composition of the product of the domestic industry. In 1957, prior to the structural change noted above, U.S. production of low-grade beef--the kind of beef which Australia is exporting--was 4,086 million pounds or 26.7% of total beef production; in 1962, this had declined to 2,753 million pounds--18.4% of total U.S. production. 4/ In the face of decline in low-grade beef production of 894 million pounds from 1957-58, cow prices at Chicago increased from \$13.61 per cwt. to \$18.41 per cwt. Yet, a decline in production of 1,164 million pounds from 1957 to 1962 has been accompanied by an increase in price of only \$1.89 per cwt. 5/ As previously noted, slaughter steer prices remained essentially unchanged during 1958-62; however, they did increase from \$23.83 per cwt. to \$27.67 per cwt. from 1957 to 1962. In view of these differential changes in prices, it may be reasonable to argue that the large supplies of high quality beef which resulted in such drastic price reduction in 1963 and early 1964 is the consequence of the increased

/3 In 1958, the U.S. imported 17.7 million pounds of beef and veal from Australia. In 1962 imports from Australia were 444.9 million pounds--81% of the 549 million pounds of beef and veal exported by that country in that year. Source: Livestock and Meat Situation, E.R.S., U.S.D.A., November 1963, pp. 35, 48.

/4 Ibid, p. 36.

/5 The price changes referred to here are over the 1957-62 period and, therefore, are not to be confused with the price changes from 1958-63 mentioned on page 1.

volume of imports during the preceding five years which served to depress cow prices. If imports had not been available, any short supply of cow beef would have resulted in higher cow prices relative to steer prices, encouraging producers to sell more cows, thereby reducing the magnitude of the increase in slaughter steer supplies, and modifying the composition of the cattle inventory on hand today.

Thus, a complete answer regarding the impact of beef imports on the domestic cattle market must necessarily consider:

- (1) The direct effects of increased competition in the market at a given point in time; and
- (2) The indirect, more subtle, effects on the historical development of the entire U.S. cattle industry.

Unfortunately, this report will not contribute greatly toward appraising these indirect effects. It is believed, however, that some insight into the problem can be gained from the analyses discussed in the following pages.

Effects on U.S. Prices: Market Situation I

A recent publication of the Oregon Agricultural Experiment Station 6/ has been utilized to provide the basic framework of the statistical demand equation presented below. The average price received by U.S. farmers for beef cattle can be expressed as a function of the quantity of beef supplied, the level of personal disposable income, the value of by-products, population, and the general price level. For the purposes of this analysis, the quantity of beef supplied was broken down into two classes--the amount of "steer and heifer beef," i.e., high grade beef, and cow and bull beef plus imports (adjusted to include the meat equivalent of live animals imported). 7/ The estimated equation for the period 1947 through 1962 is:

$$(1) \quad P_t = 11.50438108 - 0.33417939 Q_t^S - 0.40867734 (Q_t^C + Q_t^I) \\ \quad \quad \quad \quad \quad \quad (0.0648) \quad \quad \quad (0.0862) \\ \quad \quad \quad + 1.77156200 P_t^B + 0.01778187 Y_t + u_t \\ \quad \quad \quad \quad \quad (0.2717) \quad \quad \quad (0.0033)$$

$$R^2 = 0.97795613$$

$$s_{1.2345} = 0.798$$

where P_t is the average price received by U.S. farmers for beef cattle, per cwt., year t , deflated by the Consumer Price Index for that year;

Q_t^S is the quantity of steer and heifer beef supplied in year t divided by the U.S. population eating out of civilian supplies on July 1, of that year, i.e., per capita supply of steer and heifer beef, year t ;

Q_t^C is the per capita supply of domestically produced cow and bull beef, year t ;

Q_t^I is the per capita supply of imported beef (including meat equivalent of live animals imported), year t ;

P_t^B is the value of by-products, year t , deflated by the Consumer Price Index;

6/ Norman, D. W., Korzan, G. E., and Edwards, J. A., Economic Analysis of Beef Cattle Prices in the United States and Oregon. Oregon Agricultural Experiment Station, Bulletin 594, Corvallis, January 1964. For a complete rationale of the model specification see unpublished M.S. thesis entitled, An Economic Analysis of Beef Cattle Prices by David W. Norman, Oregon State University.

7/ This breakdown has been employed by the U.S.D.A. in an analysis of choice steer and utility cow prices at Chicago reported in Livestock and Meat Situation, E.R.S., U.S.D.A., November 1963, pp. 35-51. Data used to estimate the equations presented herein is reproduced in the Appendix.

Y_t is the per capita personal disposable income, year t deflated by the Consumer Price Index; and
 u_t is the amount of P_t which is not attributable to any of the other variables appearing on the right-hand side of the equation. 8/

According to these results:

- (1) An increase of one pound per capita in the supply of steer beef would result in a decrease in the average price of beef cattle of \$0.33 per cwt., of course, the larger the population the larger the change required in total steer beef production to bring about this result;
- (2) An increase of one pound per capita in the supply of either cow or imported beef, or a change in both resulting in a total increase of one pound, would result in a decrease in cattle prices of approximately \$0.41 per cwt.;
- (3) An increase in the value of by-products of one dollar in real terms (adjusted for any change in general price level) would increase beef cattle prices by \$1.77 per cwt.; and
- (4) An increase of one dollar per capita in real purchasing power (consumer disposable income) would increase the prices of cattle by about \$0.02 per cwt.

Some idea of the success of the equation in "explaining" cattle prices can be gleaned from the data in Table 1. For convenience, the actual and estimated prices are also presented graphically in Figure 1.

8/ For readers unacquainted with statistical measures of reliability, the following remarks concerning the interpretation to be attached to the estimates may be helpful. The figures appearing in parentheses beneath the several coefficients of the equation are termed standard errors. If the coefficient is more than approximately three times as large as its standard error, the probability of having obtained the estimated value, if in fact the true value was zero, is less than one in a hundred, and the estimate is referred to as statistically significant. All of the coefficients reported here are significant. The statistic R^2 can be interpreted as a measure of the proportion of the variation in P_t "explained" by variations in the other variables of the equation other than u_t ; in this case 97.8% of the variation is accounted for by the variables. Finally, $s_{1.2345}$ indicates that approximately 67% of the values of u_t lie between +0.798 and -0.798. The sum of the u_t is equal to zero.

Table 1. Actual and Estimated Average Price Received by U.S. Farmers for Beef Cattle, 1947-62

Year	Average price of beef cattle		Difference (u_t)
	Actual ^a	Estimated ^b	
	Dollars/cwt.	Dollars/cwt.	Dollars/cwt.
1947	18.40	17.77	+0.63
1948	22.20	22.24	-0.04
1949	19.80	20.23	-0.43
1950	23.30	23.15	+0.15
1951	28.70	29.19	-0.49
1952	24.30	23.93	+0.37
1953	16.30	16.86	-0.56
1954	16.00	15.57	+0.43
1955	15.60	15.88	-0.28
1956	14.90	16.04	-1.14
1957	17.20	17.45	-0.25
1958	21.90	19.97	+1.93
1959	22.60	22.84	-0.24
1960	20.40	20.24	+0.16
1961	20.20	20.28	-0.08
1962	21.30	21.14	+0.16

a Source: Livestock and Meat Statistics, 1962. Stat. Bul. No. 333, Statistical Reporting Service, A.M.S., U.S.D.A., July 1963, p. 261.

b Estimate derived from price equation has been multiplied by the consumer price index in order to express it in current dollars directly comparable with the actual prices shown in column two.

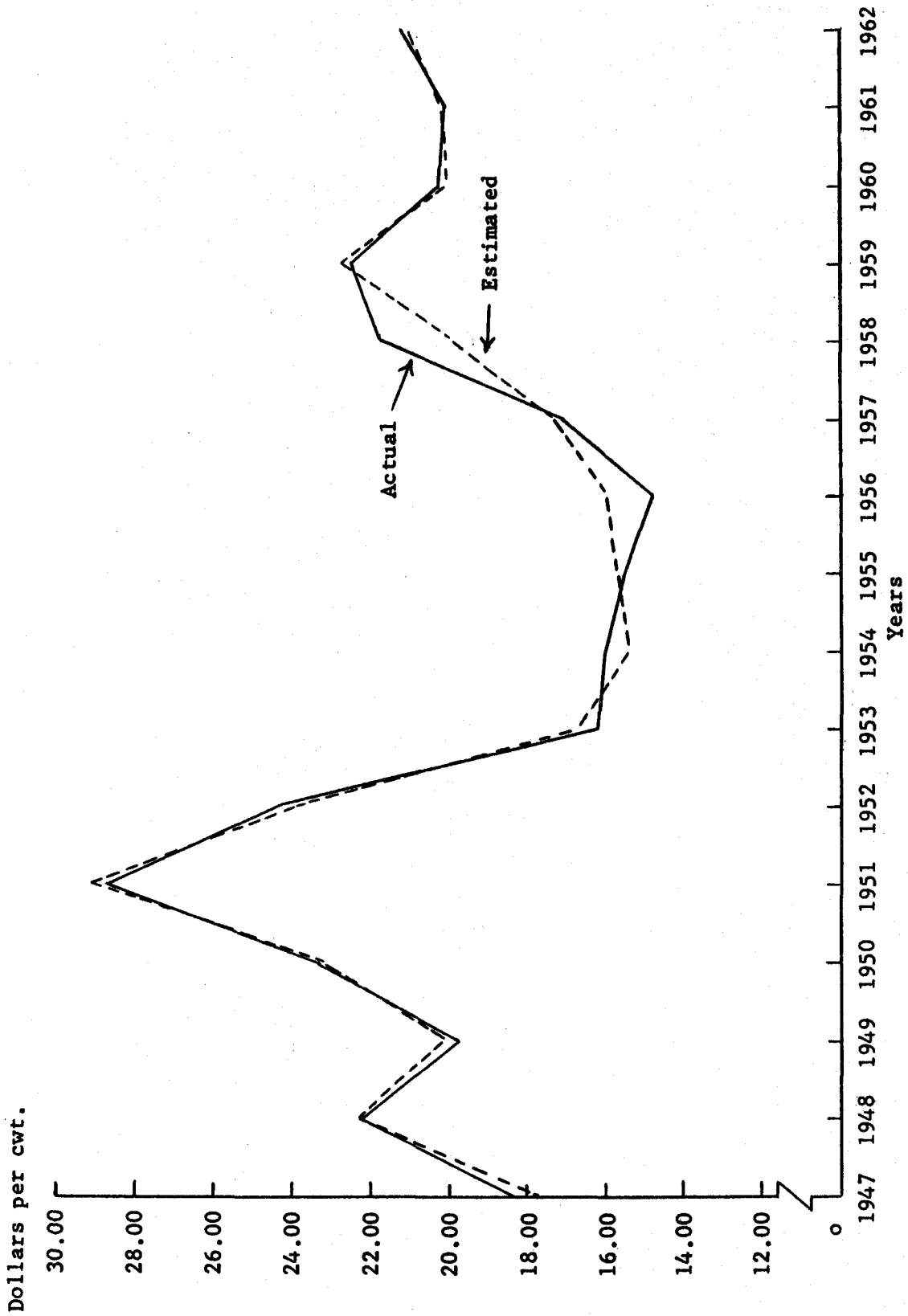


Figure 1. Actual and Estimated Average Price (Current Dollars) Received by U. S. Farmers for Beef Cattle, 1947-62. Equation (1)

Two assumptions implicit in equation (1) should be noted. The first of these is that the supply of beef coming on the market in any one year is a predetermined variable, i.e., supply is not a function of (does not depend upon) current price in the market. In particular, it means that the quantity of imports arriving in the U.S. market in a given year is determined independently of the U.S. market. This, in turn, implies that imports to the U.S. market occur as a result of over-production in the exporting country; not as a result of insufficient supply in the importing country. If such were the case, ownership of beef imports would logically reside in the exporters of those supplies rather than the importers at the time of shipment from the exporting country. In other words, importers are not actively soliciting supplies in over-seas markets because, under this assumption, the quantities supplied by the domestic industry would always be sufficient to meet the desired level of supply. Under these circumstances, imports are always competitive with domestic supplies, and an increase in imports will always depress domestic prices. Conversely, a decrease in imports will serve to raise domestic prices.

The second assumption which deserves emphasis is that of perfect substitution between domestically produced cow beef and off-shore beef of similar quality. In simple terms, this implies that a given decrease in domestic cow beef production will have no effect upon the average price of all domestically produced cattle if it is accompanied by an increase of equal volume in the quantity of beef imported. Furthermore, the rate at which beef from these two sources can be substituted for one another is independent of the volume of either of them, i.e., the effect upon price of a given increase in imports will be the same when the production of domestic cow beef is equivalent to one pound per capita as it will be when domestic production is a hundred, or a thousand, pounds per capita.

The consequences of these assumptions are indicated in Table 2, where the effects on the average U.S. farm price of cattle attributable to the actual changes in the variables determining price, according to equation (1), are indicated for the period 1957-1962. In each case, it is assumed that all of the other variables had remained at their levels of the previous year. Of the \$3.10 per cwt. increase in average farm price which occurred from 1957-1962, increased real income accounted for \$1.81 of the increase; increased by-product values raised prices by \$0.83 per cwt.; and the decrease in domestic cow beef supplies resulted in an increase in price of \$3.39 per cwt. Price decreases of \$1.36 and \$2.41 per cwt. can be attributed to increases in steer and heifer beef production and imports, respectively. Changes in unspecified factors accounted for the difference between the actual and estimated price increase of \$0.84 per cwt. The net direct effect of changes in the market structure since 1957--primarily the unrestricted imports of

Table 2. Observed Changes in Price Determining Variables in Adjacent Years and Their Estimated Effects Upon the Average Price Received by U.S. Farmers for Beef Cattle

Variable	Year				
	1957-58	1958-59	1959-60	1960-61	1961-62
Change in Q^S (lbs.)	-3.0	+1.0	+5.3	+3.0	-2.0
Effect on price (\$)	+1.00	-0.33	-1.74	-1.00	+0.67
Change in Q^C (lbs.)	-5.7	-2.1	+0.5	-1.7	+0.7
Effect on price (\$)	+2.33	+0.86	-0.20	+0.69	-0.29
Change in Q^I (lbs.)	+3.6	-0.1	-1.9	+1.8	+2.5
Effect on prices (\$)	-1.47	+0.04	+0.78	-0.74	-1.02
Change in (Q^C+Q^I) (lbs.)	-2.1	-2.2	-1.4	+0.1	+3.0
Effect on price	+0.86	+0.90	+0.58	-0.05	-1.31
Change in P^B (\$)	+0.39	+0.55	-0.95	+0.25	+0.23
Effect on price	+0.69	+0.97	-1.68	+0.44	+0.41
Change in Y (\$)	-27.50	+63.50	-1.00	+24.10	+47.00
Effect on price (\$)	-0.49	+1.13	-0.02	+0.43	+0.84
Total est. change in price	+2.06	+2.67	-2.86	-0.28	+0.61
Actual change in price	+4.70	+0.70	-2.20	-0.20	+1.10
Change in price due to changes in consumer price index, population and unspecified factors (u_t)	+2.64	-1.93	-0.66	-0.08	+0.49

beef into the domestic market--has been to increase cattle prices by \$0.98 per cwt. through 1962. This has been the consequence of a greater reduction in domestic cow beef production on a per capita basis than the accompanying increase in import volume.

However, one must also recognize that increased imports have also had an indirect effect. Insofar as the reduction in domestic cow beef production has been in response to the depressing effect of imports on cow prices--an effect well demonstrated by the U.S. Department of Agriculture analysis of the effect of imports on choice slaughter steer and utility cow prices at Chicago ⁹--some of the increase in steer beef production can be attributed to imports. Consequently, some portion of the decrease in price resulting from such an increase in supplies must be debited against imports. While no attempt has been made to estimate this indirect effect, it can be assumed that it must lie in the range between nothing and a price-decreasing effect of \$1.36 per cwt., representing no supply response and a 100% response, respectively. Thus, the sum total of direct and indirect price effect as a consequence of the increase in imports lies in the range from -\$0.38 to +\$0.98 per cwt.

The above conclusions are predicated on the assumption that cow beef production has been adjusted as a consequence of imports entering the U.S. markets. If one were to assume, however, that the observed changes in cow beef production would have occurred even if imports had not increased, domestic cattle price would have been approximately \$1.05 per cwt. higher in 1962 if imports had been maintained at their 1957 levels.

Finally, if it is assumed that the domestic cattle industry had supplied sufficient cow beef to make the total supply of low-grade beef in each year since 1957 equal to the actual supply, it is estimated that the average price received by U.S. farmers in 1962 would have been approximately \$3.78 per cwt. higher. ¹⁰ This estimate is derived from equation (1) after estimating the per capita supply of steer and heifer beef which would have been available in 1962 if cow slaughter had increased sufficiently in each of the years 1958 to 1962 to offset the loss of all increases in imports since 1957. Of course, this estimate is based upon a sizable decrease in steer beef production. Available data do not permit one to determine whether the estimated increase in price is sufficiently great to

⁹ Op. cit., p. 41.

¹⁰ Details of the method employed in forming this estimate are presented in Appendix B.

compensate producers for the reduction in marketings. The reader is cautioned not to place too much confidence in this estimate. 11/

To summarize then, imports may have had any one of the following effects on domestic cattle prices:

- (1) An increase of \$0.98 per cwt. (if domestic producers adjust cow marketings in response to increases in imports, without increasing steer beef production thereby);
- (2) A decrease of \$0.38 per cwt. (if the observed increase in steer beef production since 1957 was the consequence of decreased cow slaughter brought about by the depressing effect of imports on cow prices);
- (3) A decrease of \$1.05 per cwt. (if the domestic production developments would have been forthcoming even in the absence of any increase in imports, i.e., if the domestic industry were in fact producing exactly the amount demanded by the market); and, finally,
- (4) A decrease of \$3.38 per cwt. (if the domestic industry had supplied the quantities of low-grade beef in excess of the 1957 import level which the market in fact absorbed in each of those years).

Once the possibility of supply response in competitive products is admitted, the estimated effects of imports on domestic cattle prices become even more indeterminant. In attempting to choose among the more specific estimates listed above, the first alternative can be dismissed without too much concern because it is based upon assumed conditions which are patently incompatible with the historical developments of the 1957-62 period. Thus, the most probable effect of imports on domestic prices has been to depress those prices by an amount ranging from \$0.38 to \$1.05 per cwt.

The estimated effects defined in this section have been obtained on the basis of the assumptions described on page 8. This is not entirely true of alternative effect (4) which is based on the assumption that total low-grade beef supply (i.e., the sum of both domestic production and imports) was the equilibrium level of supply, rather than merely that portion of the supply

/11 An additional factor which has been ignored in the above estimate is the degree to which consumers would have been able to substitute such substitutes for beef as pork, lamb, and mutton, poultry and other close meat substitutes. Because of the relatively shorter time periods required to increase the output of these products, it is conceivable that much, if not all, of the indicated increase in cattle prices would have been forestalled by the substitution of nonbeef meat products for beef.

originating domestically. The postulated effect, however, is contingent on the possibility of the domestic industry to provide such a level of supply in the absence of imports. In other words, the only reason that the domestic industry failed to produce this supply is that it was unable to compete successfully with the import sources for the superior market alternative in its own market. Consequently, it had to settle for the second best--the marketing program which the domestic industry did in fact follow subsequent to 1957. If this indeed were the case, it speaks ill for the economic efficiency of the U.S. cattle industry and its associated suppliers.

For convenience, the marketing situation in which these two assumptions are valid (that is, domestic market equilibrium-external disequilibrium, and constant rates of substitution in the domestic market between domestic and imported low-grade beef) will be referred to as market situation I. It is worthwhile to attempt to measure the import-price effect under somewhat different assumptions which are categorized as market situation II.

Effects on U.S. Prices: Market Situation II

The economic environment for the previous discussion of beef imports was assumed to be one of internal equilibrium and external disequilibrium. In the analysis developed in this section, the environment will be assumed to be characterized by internal disequilibrium. Reference to Figure 2 may be helpful in grasping the meaning of the phrase "internal disequilibrium" in the context of the cattle market.

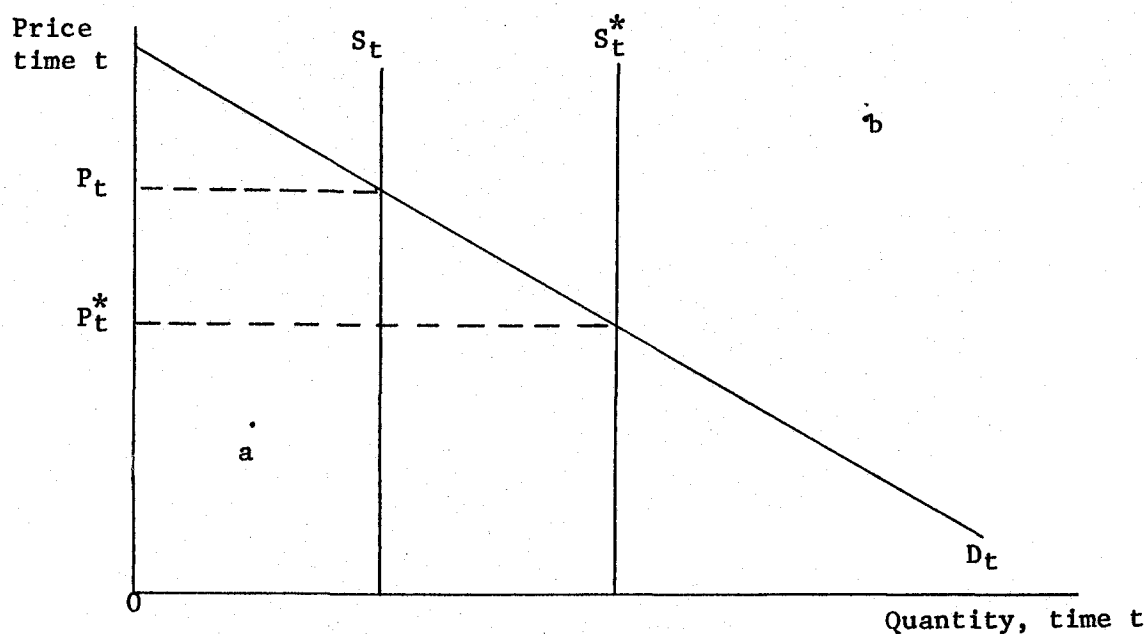


Figure 2. A Diagrammatic Representation of Market Situation II

In Figure 2, the sloping line labeled D_t represents the demand function in the market for beef; any point on the line represents the maximum quantity of beef which the market will absorb at the corresponding price, e.g., when price is equal to P_t^* the market will absorb no more than an amount indicated by the intersection of the vertical line S_t^* with the quantity axis. Demand can also be defined, in a converse sense, as a schedule of the maximum prices at which specified quantities will be absorbed by the market during the specified time period, t . It is important to realize that the function D_t separates attainable price-quantity combinations from unattainable combinations. Thus, a combination such as that indicated by the point "a" is possible, but point "b" is not.

The vertical line S_t^* is intended to indicate the amount which sellers in the market would like to have available in the market at time t . The rationale of this function is founded on the idea of seller profit maximization. If, for the moment, we assumed that sellers knew both the demand for their product and the costs involved in selling that product, there would be some combination of quantity and price at which profits would be a maximum. Under competitive market conditions, of course, knowledge of demand on the part of the individual seller is restricted to market price only, and therefore these assumptions may appear to be unrealistic. However, the behavior of an aggregate of such sellers attempting to maximize profits may closely approximate the condition imposed by these assumptions. A supply function such as S_t^* will be referred to as "desired supply"; it can be described by a single variable such as P_t^* -- the price at which seller profits will be maximized and which, once attained, will be maintained as long as the conditions affecting demand and cost remain unchanged. In this sense, then, P_t^* can be referred to as "equilibrium price."

The meaning of internal equilibrium used in reference to market situation I above can be stated very simply in terms of Figure 1. The assumption there was that the actual market supply at each and every point of time t was equal to supply, i.e., that $S_t = S_t^*$ where S_t stands for actual supply at t . It is clear, then, that (1) any increase in $(Q_t)^S$ as a result of imports would depress market prices, and (2) that such an influx of imports must have originated outside the market. This latter point is apparent when one recalls the definition of desired supply and equilibrium price given above.

Let us suppose, however, that domestic supplies are in fact less than desired supply, e.g., S_t (Figure 2). This situation is referred to as a disequilibrium situation. That it is a disequilibrium will be clear if one considers the probable course of events as it becomes apparent that S_t is less than S_t^* :

- (1) Sellers initially set prices at P_t^* anticipating that they will sell S_t^* at that price, thereby maximizing profits;

- (2) However, at a price P_t^* more of the product is demanded than sellers can supply and, consequently, inventories are drawn down at a faster than anticipated rate;
- (3) In order to protect their inventory position, or whatever other indicator which sellers may use as a measure of stability ^{12/} sellers raise prices;
- (4) This process is continued until prices are high enough to equate demand with available supply. This final price is indicated in Figure 2 by P_t .

It is customary among economists to assert that the new price is an equilibrium price because supply is now equal to demand. However, this is not true under the assumptions of this analysis because seller profits are not maximized at P_t but, as previously indicated at P_t^* . Therefore, if it is possible for sellers to obtain sufficient additional supplies to supplement S_t they will do so because in this manner they can increase profits.

One way of increasing supply beyond the domestic supply, S_t , is through imports. Let us assume that given S_t , sufficient imports are obtained to increase total supply to S_t^* . The market is now in equilibrium. Has the market price P_t^* been depressed? Obviously not, since it was the initial price in the market. What has happened, however, is that price did not increase from P_t^* to P_t . It seems reasonable to assert that starting with domestic disequilibrium, imports do not depress domestic prices as long as they do not exceed the volume required to equate actual with desired market supply. Imports in excess of this amount, however, do serve to depress prices.

Before proceeding to consider the implications of such a market situation it may be well to emphasize two points:

- (1) The existence of imports is the consequence of a failure on the part of the domestic industry to supply the market demand. This is not stated in any sense as an accusation because the motivations which led to the initial disequilibrium are not known; and
- (2) The economic gains from imports are enjoyed not only by the exporter, but are shared by the importer and the final consumer of the product as well. The importer benefits through increased profits, and the consumer benefits in being able to consume more product at a lower price.

^{12/} Since the sellers in this market are not producers, it is probable that the first indication which they receive of deficient supplies is an increase in the wholesale prices which they have to pay brought about by competition among themselves for the restricted supply. These increases in costs are then passed on to consumers in whole or in part.

This market situation has been expressed mathematically in the following system of equations:

$$(2) P_t^* = A_0 + A_1 Q_t^S + A_{2t} (Q_t^I + Q_t^C) + A_3 P_t^B + A_4 Y_t$$

$$(3) A_{2t} = B_1 Q_t^I$$

$$(4) Q_t^I = C_0 + C_1 (P_t - P_t^*)$$

Equation (2) represents the demand function at time t . Its position varies with changes in the value of by-products and consumer income. Equation (3) reflects the assumption that the response in market price to a given change in the total supply of low-grade beef depends upon the magnitude of the disequilibrium existing in the market. Equation (4) defines imports as a measure of the extent of the disequilibrium. 13/

P_t^* is, of course, an unobserved variable. Consequently it becomes necessary to combine these three equations into some combination involving only observable variables if statistical estimation is to be undertaken. This was accomplished in this case by re-writing equation 4:

$$(4^1) P_t = \left(\frac{-C_0}{C_1} \right) + \frac{1}{C_1} Q_t^I + P_t^*$$

and substituting equation (2) defining P_t^* into the right-hand side after inserting the definition of A_{2t} from equation (3). 14/ The statistically estimated function is:

$$(5) P_t = 22.42234538 - 0.40314183 Q_t^S - 0.08267041 Q_t^I (Q_t^I + Q_t^C) \\ (0.04598) \quad (0.01902) \\ + 2.59834616 Q_t^I + 1.11127030 P_t^B + 0.00870322 Y \\ (0.46615) \quad (0.22155) \quad (0.00338)$$

$$+ u_t$$

$$R^2 = 0.98949929$$

$$s_{1.23456} = 0.578$$

The variables involved have been defined previously.

A comparison of the statistical measures of reliability from equation (5)

/13 The constant, C_0 in equation (4) represents "autonomous" imports--imports which would have occurred regardless of domestic market conditions. Such imports may consist of specialty products and other beef products not domestically produced.

/14 The estimating equation fails to meet the usual assumption of least-squares analysis if equation (3) is assumed to be stochastic, in that the combined error will include a term involving the independent variable $(Q_t^I + Q_t^C)$.

Table 3. Actual and Estimated Average Price Received by U.S. Farmers for Beef Cattle, 1947-62

Year	Average price of beef cattle		Difference (u_t)
	Actual ^a	Estimated ^b	
	Dollars/cwt.	Dollars/cwt.	Dollars/cwt.
1947	18.40	18.10	+0.30
1948	22.25	22.85	-0.60
1949	19.80	19.92	-0.12
1950	23.30	22.99	+0.31
1951	28.70	28.58	+0.12
1952	24.30	24.07	+0.23
1953	16.30	16.68	-0.38
1954	16.00	15.93	+0.07
1955	15.60	16.01	-0.41
1956	14.90	14.93	-0.03
1957	17.20	16.83	+0.37
1958	21.90	21.01	+0.89
1959	22.60	23.24	-0.64
1960	20.40	19.72	+0.68
1961	20.20	20.54	-0.34
1962	21.30	21.68	-0.38

a Source: Livestock and Meat Statistics, 1962. Stat. Bul. No. 333, Statistical Reporting Service, A.M.S., U.S.D.A., July 1963, p. 261.

b Estimates derived from price equation (5) have been multiplied by consumer price index in order to express them in current dollars.

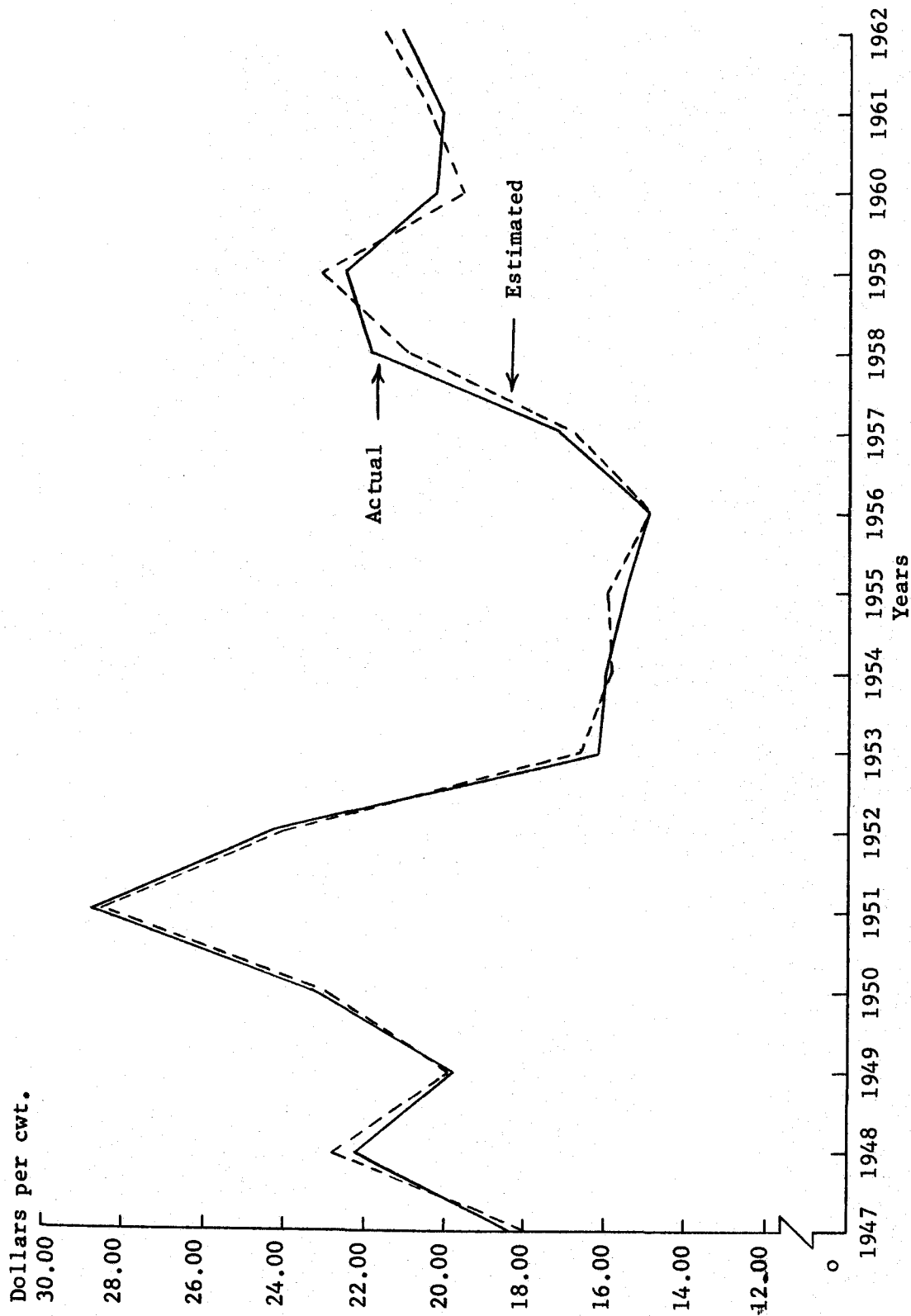


Figure 3. Actual and Estimated Average Price (Current Dollars) Received by U. S. Farmers for Beef Cattle, 1947-62. Equation (5)

with those of equation (1) indicates that, from a statistical viewpoint, both equations are of almost equal value. ^{15/} Any advantage must be given to equation (5) since it succeeds in "explaining" 50% of the variation in P_t which equation (1) failed to explain. The estimated prices from (5) are shown in Table 3 and Figure 3.

Solution of the equations defining the reduced-form parameters which have been estimated, yields the following empirical counterpart to the system of equations (2) - (4):

$$P_t^* = A_0 - 0.40314183 Q_t^S + A_{2t} (Q_t^I + Q_t^C) + 1.11127030 P_t^I + 0.00870322 Y_t$$

$$A_{2t} = -0.08267041 Q_I$$

$$Q_I = C_0 + 0.38486019 (P_t - P_t^*)$$

$$C_0 = 0.38486019 A_0 - 8.62946810$$

The effects of year-to-year changes in all of the variables with the exception of Q_t^I and Q_t^C upon prices can be estimated from equation (5) in the same manner as they were from equation (1) for market situation I. These effects are shown in Table 4 for the years 1957-58 through 1961-62.

Table 4. Estimated Effects of Observed Changes in Selected Variables upon the Average Price received by U.S. Farmers for Beef Cattle

Year	Effect on price of change in -		
	Q_t^S	P_t^B	Y_t
	Dollars per cwt.	Dollars per cwt.	Dollars per cwt.
1957-58	+1.21	+0.43	-0.24
1958-59	-0.40	+0.61	+0.55
1959-60	-2.10	-1.06	-0.01
1960-61	-1.21	+0.28	+0.21
1961-62	+0.81	+0.26	+0.41

The estimates presented in Table 1 indicate that the estimated effects are greater for changes in steer beef production (Q_t^S) in market situation II than in situation I. Changes in by-product value and disposable income have smaller impacts on price.

^{15/} The coefficient of Y is significant at the 5% level; all others at the 1% level.

The problem of evaluating the price effect of changes in domestic cow beef production and imports is somewhat more involved in the case of situation II than it was in situation I. In the latter, a given change in either Q_t^I or Q_t^C or their sum, would always have the effect of changing price by a constant amount. For example, a one pound per capita increase in any of these three variables would decrease price by approximately \$0.41 per cwt., i.e., the marginal price effect of a one unit change in Q_t^C , Q_t^I , or $(Q_t^C + Q_t^I)$ was always equal to -0.40867734 cents per cwt. In contrast, the marginal price effects of Q_t^C and Q_t^I in situation II are functions of the levels of Q_t^C and Q_t^I from which the change occurs. The equations defining these effects are:

$$(6) \text{ For changes in } Q_t^C : \frac{\partial P}{\partial Q_t^C} = -0.08267041 Q_t^I \quad \underline{16/}$$

$$(7) \text{ For changes in } Q_t^I : \frac{\partial P}{\partial Q_t^I} = 2.59834616 - 0.08260741 (2Q_t^I + Q_t^C)$$

As long as the quantity of imports remains unchanged, the effect of a given change in Q_t^C is constant. The same cannot be said of the effect of a given change in imports. As soon as Q_t^I changes, the magnitude of the price effect also changes. Since the volume of imports has been postulated to depend upon the difference between actual and desired cow beef production, it has been concluded that the appropriate indicator of import impact is to compute the marginal price effects at the beginning and conclusion of a given marketing year. These estimates are presented in Table 5.

Table 5. Marginal Import-Price Effects at Beginning and Ending of Marketing Years, 1957-62

Year	Marginal Import-Price Effect at	
	Beginning of year ^a Dollars per cwt.	End of year ^b Dollars per cwt.
1957	+0.1667	-0.0253
1958	-0.0253	-0.1473
1959	-0.1473	+0.0429
1960	+0.0429	+0.3158
1961	+0.3158	+0.1597
1962	+0.1597	-0.2817

a Computed from equation (7) using previous year's values of Q_t^C and Q_t^I .

b Computed from equation (7) using current year's values of Q_t^C and Q_t^I .

16 The mathematical symbol $\frac{\partial P}{\partial Q^C}$ indicating the instantaneous rate of change in price with respect to cow beef production has been employed here.

In interpreting these figures an example or two may prove helpful. In 1959, existing market conditions at the beginning of the marketing year made additional imports at that time price depressing. By the end of the marketing year, however, market changes occurring during the course of the year were such that imports were no longer price depressing. In 1962, the reverse situation prevailed. Thus, a positive effect can be interpreted as indicating the existence of a shortage of low-grade beef in the market. The magnitude of the effect indicates the inflationary pressure being exerted on domestic cattle prices. A negative effect indicates an over-supply of low-grade beef. The magnitude of this effect indicates the deflationary effect of excess supplies on domestic cattle prices. 17/

An alternative way of determining whether or not imports in a given year were depressing on domestic cattle prices is to set equation (7) equal to zero, and solve for Q_t^I using the actual value for Q_t^C . The resulting value of Q_t^I will be neither price depressing nor price inflating. If actual imports are greater than the computed value, imports were price depressing. If they were less than the computed value, imports did not affect cattle prices. The results of such computations are shown diagrammatically in Figure 4. The diagonal line running from the vertical Q_t^C to the horizontal axis represents the various combinations of Q_t^C and Q_t^I satisfying the equation

$$(8) Q_t^I = \frac{1}{2} (31.4318 - Q_t^C)$$

which was obtained from equation (7) in the manner prescribed. The various combinations of Q_t^C and Q_t^I occurring during the period 1947-62 are plotted as points in the field. If a particular combination lies on the diagonal line, it would be consistent with market equilibrium. If it lies below the line, a situation of deficient supply in the domestic market is indicated. If the point lies above the line, a condition of excess supply existed in the market. The excess supply can be removed by any combination of reduction in Q_t^C and Q_t^I which would place the point on the diagonal line. It is apparent that of the 16 years indicated, market equilibrium occurred in only one year--1955. In only three years were imports price depressing--1957, 1958, and 1962. 18/

A comparison of the estimates of import-price effects under the different market situations during the period 1958-62, reveals some apparent discrepancies. In market situation I, the direct effect of the increase in imports from 1960 to 1961 was estimated to have depressed prices by \$0.74 per cwt. (see Table 2). In contrast, the analysis of market situation II (Table 5) shows that the increase in imports was not price depressing. It will be noted, however, that the magnitude of the inflationary pressures in the market was reduced.

17/ The hypothesis that a shortage of domestic beef relative to desired supply results in imports, should not be interpreted as a hypothesis that the import volume is always equal to the difference. Importers may either fail to buy adequate supplies, or buy more than an amount sufficient to maximize profits.

18/ Preliminary data indicate that 1963 import levels were also price depressing, approximately equivalent in effect to that indicated for 1962 in Table 5.

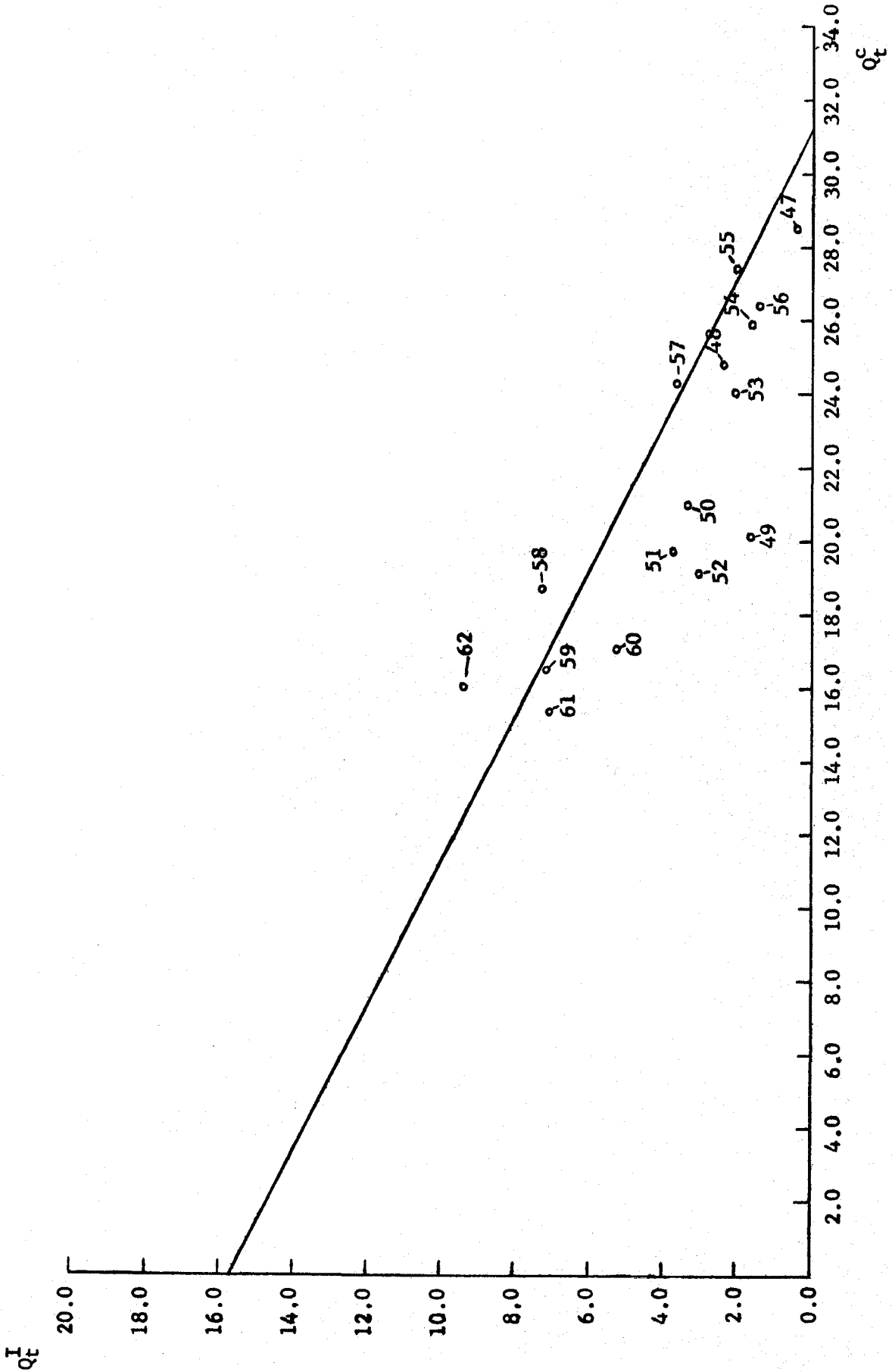


Figure 4. Actual Market Combinations of Beef Imports and Domestic Cow Beef Production, 1947-1962, Relative to Market Equilibrium.

While there are no other directly contradictory results, the magnitudes of the price effects under alternative I are consistently greater than under situation II. The exception occurred during 1959 when the estimated effect under I was to all intents equal to the inflationary pressure indicated in Table 5.

Although these results may appear to be contradictory, they are exactly what one could expect as a result of the specification of the market situations. During 1961, the assumption of domestic market equilibrium (situation I), disturbed by an increase in import volume, leads automatically to a reduction in cattle prices. Under situation II, an increase in imports will not necessarily depress prices. The extent of the market disequilibrium in 1961 was sufficiently great to permit the market to absorb the increased import volume without depressing price, thereby moving the market closer to an equilibrium position.

Similar interpretations are in order for the other results observed. The increase in import volume in 1958 which resulted in such a large decrease in cattle prices under situation I, was only partially deflationary under situation II. A large part of the increase in import volume which occurred was absorbed in moving from a market disequilibrium position to one of equilibrium. Only after these market needs were met could imports become price depressing.

Obviously, the conclusion which one reaches concerning the effects of changes in import volume on cattle prices in the U.S. market depends upon the assumptions which one is willing to make as to the motivations of the buyers and sellers in the market, both domestic and foreign. Only two of many possible assumptions of market performance have been discussed here. To be more exact, only one market mechanism has been employed since market situation I is merely a special case of the more general formulation referred to as market situation II. In view of the more general nature of the latter model, and the more realistic nature of the assumptions involved, one may wish to use caution when embracing the conclusions of an analysis as simple in conception as that involved in market situation I.

Application to Import Policy

In concluding this report, a brief note concerning the possibility of using the model embodied in equation (5), or one with similar properties, in reaching decisions regarding beef import policy may be in order. Assuming that some system of import quotas might be adopted by the United States Government, the question arises concerning the level at which such quotas should be established. Although many criteria may be employed in making this determination, one set which has a number of desirable features would be that the quota established should provide that:

1. Producers should not be subjected to competition from imports which are price depressing, but at the same time,
2. Income transfers from other agents in the marketing system and/or from consumers to producers as a consequence of inadequate market supplies should be avoided.

Such a quota, naturally, would have to vary with changing conditions of supply and demand in the domestic market if these objectives were to be met.

The criteria stated above are essentially those conditions which satisfy market equilibrium in market situation II discussed above. To implement such a policy, the Federal agency empowered to set the quota would first make an estimate of the per capita supply of domestic cow beef for the quota period. Then equation (8) could be used to determine the per capita supply of imported beef required to make the marginal import-price effect equal to zero. Converting this per capita estimate to total volume by multiplying by population would establish the quota.

Periodic recomputation of equation (5), substituting data as it becomes available for the observations most distant in time, e.g., 1963 data included and 1947 data removed when estimating the 1964 quota, would serve to prevent the livestock industry and consuming public from becoming shackled to some historical base not necessarily characteristic of the changing world of consumer taste and production technology.

An example of how such a procedure would have operated during the period commencing in the fourth quarter 1961 through fourth quarter 1963 has been worked out for illustrative purposes. Quarterly data on number of cattle slaughtered, etc., were employed to obtain estimates of quarterly cow beef production which were multiplied by four and divided by U.S. quarterly population consuming domestic food supplies. The resulting estimates indicated the annual rate of per capita cow beef production in each of the nine quarters under consideration. These estimates are presented in Table 6, together with the estimated equilibrium level of per capita imports (Q_F^{I*}) computed from equation (8). In the fourth column, Q_F^{I*} has been converted to total pounds by multiplying Q_F^{I*} by the population during the corresponding quarter. This latter figure is the suggested quota for the quarter at an annual rate and must be divided by four to obtain the quota for the quarter.

In Table 7, actual import volume (including meat equivalent of live animals imported) is compared with the estimated equilibrium import levels. The estimated import-price effects have been computed from equation (7) and are also shown in Table 7. ^{19/} These pertain, of course, to the effects

^{19/} The indicated import-price effects imply annual values of $-\$0.22$ and $-\$0.35$ for 1962 and 1963, respectively. These results can be considered as indicative of the magnitude of the effects of market disequilibrium during relatively short periods of time.

which actually were exerted on the domestic market; under the quotas computed above, the negative effects would have been, presumably, eliminated and the corresponding entries would be zero.

Some of the advantages of quotas determined in this manner are demonstrated by this example. First, the quota is flexible, changing automatically with changes in the market environment. Insofar as imports tend to move in concert with domestic cow beef production over the course of the marketing year--the data in Tables 6 and 7 seem to support this contention--the suggested quotas may exert a contra-seasonal effect in the market. Thus, the quota increases when domestic production is at its seasonal low (II quarter) but decreases when production reaches its seasonal high (IV quarter).

Table 6. Estimated Per Capita Production of Cow Beef, Equilibrium Per Capita Imports and Suggested Quota, by Quarters at Annual Rates, Quarter IV, 1961 through Quarter IV, 1963

Year and quarter	Estimated per capita cow beef production pounds	Estimated equilibrium per capita beef imports pounds	Suggested quota mil. pounds
1961: IV	17.3	7.1	1,286
1962: I	14.7	8.4	1,527
II	14.1	8.7	1,587
III	16.8	7.3	1,345
IV	18.0	6.7	1,240
1963: I	13.8	8.8	1,634
II	13.0	9.2	1,714
III	15.2	8.1	1,514
IV	17.2	7.1	1,334

Table 7. Estimated Quarterly Beef Imports, Suggested Quarterly Quotas, and Estimated Marginal Import-Price Effects (Annual Rate), by Quarters, IV, 1961 through IV, 1963.

Year and quarter	Estimated quarterly beef imports	Suggested import quota	Estimated marginal import-price effect
	million pounds	million pounds	dollars/cwt.
1961: IV	341.2	321.5	-0.07
1962: ^a I	392.5	381.8	-0.04
II	334.2	396.8	+0.23
III	455.0	336.2	-0.42
IV	535.8	210.0	-0.81
1963: I	445.0	408.5	-0.13
II	400.0	428.5	+0.10
III	550.5	378.5	-0.61
IV	550.5	333.5	-0.77

^a Estimated total imports reported here were 1,717.5 million pounds in 1963; as reported in Livestock and Meat Situation, A.M.S., U.S.D.A., November 1963, they were 1,725.0 million pounds.

Appendix Table I. Data Employed in Estimating Price Equations (1) and (5)

Year	Production of beef and veal (incl. meat equiv. of live animals)		Imports of beef and veal (incl. meat equiv. of live animals)		By-product allowance \$ per cwt.	Personal disposable income billion \$	U.S. population eating out of civilian supplies Apr. 1	Consumer price index (1957-59 = 100)
	mil. lbs.	mil. lbs.	mil. lbs.	mil. lbs.				
1947	18.40	7,564	4,025	64	6.30	168.3	143.5	77.8
1948	22.20	6,495	3,594	356	6.60	186.9	146.1	83.8
1949	19.80	7,412	2,970	254	5.40	189.7	148.6	83.0
1950	23.30	7,235	3,150	505	6.30	207.7	151.6	83.8
1951	28.70	6,543	2,978	575	8.50	227.5	153.7	90.5
1952	24.30	7,482	2,935	476	5.50	238.7	156.4	92.5
1953	16.30	9,760	3,746	333	4.20	252.5	159.0	93.2
1954	16.00	10,031	4,121	267	4.00	256.9	161.8	93.6
1955	15.60	10,251	4,449	322	3.70	274.4	164.6	93.3
1956	14.90	11,262	4,369	254	3.70	292.9	168.2	94.7
1957	17.20	11,208	4,086	616	4.00	308.8	171.2	98.0
1958	21.90	10,894	3,192	1,249	4.50	317.9	174.0	100.7
1959	22.60	11,278	2,884	1,254	5.10	337.1	177.0	101.5
1960	20.40	12,387	3,012	938	4.20	349.4	180.7	103.1
1961	20.20	13,137	2,753	1,287	4.50	363.6	183.7	104.2
1962	21.30	12,945	2,922	1,725	4.80	382.9	186.6	105.4

Sources: Ave. Price: Livestock and Meat Statistics, 1962, Statistical Bulletin No. 333, E.R.S., U.S.D.A., July 1963, p. 261.

Production of steer beef) Livestock and Meat Situation, A.M.S., U.S.D.A., November 1963, p. 36.
 Production of cow beef)
 Imports of beef)

By-product allowance: (1947-61) Farm Retail Price Spreads for Food Products, Misc. Pub. 741 and supplements thereto, A.M.S., U.S.D.A.; (1962) Marketing and Transportation Situation, A.M.S., U.S.D.A.

Personal disposable income: (1947-61) Agricultural Statistics, 1963, U.S.D.A., p. 511;
 (1962) Survey of Current Business, U.S.D.C.

Population: Agricultural Statistics, 1963, U.S.D.A., p. 524.

Consumer price index: (1947-61) Agricultural Statistics, 1963, U.S.D.A., p. 511; (1962) Monthly Labor Review, B.L.S., U.S.D.L.

APPENDIX B

Method of Estimating Price Effect Assuming
Domestic Cow Beef Supply 1958-62 Equal
To Total Supply of Low Grade
Beef Less 1957 Import Volume.

It is assumed that imports in each year from 1958 thru 1962 are equal to 3.7 pounds per capita, but that total supply of low grade beef is equal to the actual amount absorbed by the market:

- (1) $Q_t^I - 3.7 =$ Additional cow beef production per capita required (ΔQ_t^C)
- (2) $\Delta Q_t^C \times \text{Population}_t =$ Total additional cow beef production required ($\Delta Q_t^{C'}$)
- (3) $\Delta Q_t^{C'} \div \text{Average dressed weight, cows, Chicago}_t =$ Increase in cow slaughter (ΔN_t^C)
- (4) Cows and heifers (2 years old and over) on farms, January 1 (other) $_{t+1} - \Delta N_t =$ Adjusted January 1 inventory (I'_{t+1})
- (5) $I'_{t+1} \times \text{Calves born per cow}_{t+1} =$ Adjusted beef calf crop (C'_{t+1})
- (6) $I_{t+1} \div \text{Calves born per cow}_t =$ Actual beef calf crop (C_{t+1})
- (7) $\text{Number of calves commercially slaughtered}_{t+1} \div \text{Total calf crop (including dairy calves)}_{t+1} =$ Percent of calf crop slaughtered $_{t+1}$
- (8) $(C_{t+1} - C'_{t+1}) \times \text{Percent of calf crop slaughtered}_{t+1} =$ Reduction in calf slaughter (ΔC_{t+1}^S)
- (9) $\Delta C_{t+1}^S \div \text{Number of calves slaughtered}_{t+1} =$ Percent reduction in veal production $_{t+1}$
- (10) $\text{Actual veal production}_{t+1} \times (100 - \text{Percent reduction in veal production}_{t+1}) \div 100 =$ Adjusted veal production ($P_{t+1}^{V'}$)

- (11) $C'_{t+1} \times \text{Percent of calf crop slaughtered} = \text{Adjusted calf slaughter}_{t+1}$
- (12) $C'_{t+1} - \text{Adjusted calf slaughter}_{t+1} = \text{Adjusted steer slaughter}_{t+2}$
 (S'_{t+2})
- (13) $C_{t+1} \times (100 - \text{Percent of calf crop slaughtered})_{t+1} = \text{Actual steer slaughter}_{t+2} (S_{t+2})$
- (14) $100.0 - (S'_{t+2} \div S_{t+2}) \times 100 = \text{Percent reduction in steer beef production}_{t+2}$
- (15) $\text{Actual steer beef production}_{t+2} \times (100 - \text{Percent reduction in steer beef production}_{t+2}) \div 100 = \text{Adjusted steer beef production}_{t+2}$
 $(P^{s'}_{t+2})$
- (16) $P^{s'}_t + P^{v'}_t = \text{Total adjusted steer beef and veal production}$
- (17) $\text{Total adjusted steer beef and veal production} \div \text{population} = Q_t^{s'}$

Since the increase in domestic cow beef production exactly offsets the decrease assumed for imports, no change in price from this source is involved.

- (18) $P'_t - P_t = -0.33417939 (Q_t^{s'} - Q^s)$
 $Q^{s'}$ is less than Q_t^s ; thus, $P'_t > P_t$.