8

Deflation

If the position of the demand curve remains constant, it is easy to determine the elasticity; one simply plots the price data against the production data in an ordinary scatter-diagram, and draws in the demand curve through the dots. But in actual life, demand curves constantly shift their position—sometimes only to a small extent, but sometimes violently. These shifts in demand curves scatter the intersection points all over the scatter-diagram, so that the dots do not fall on a single negatively sloping line; they may even cluster around a positively sloping line, or show no tendency to cluster around any line at all.

What is needed is some way to hold the demand curve still by statistical means, so that the changes in supply cut a stationary demand curve. This enables the investigator then to measure the elasticity and shape of the demand curve, as traced out by the shifting supply curve cutting it at a number of points.

One of the simplest ways to hold the demand curve still is to divide the price series by some measure of the forces that shift it about. Thus if general inflation has doubled the general level of prices, including the price of the good in question, then dividing the prices of the good by the corresponding index of the general price level each year will in effect hold the demand curve still. This process, designed to get rid of the effects of general inflation on the good in question, is called "deflation."

But this process is effective and accurate only if the relation between the price of the good and the "deflator" is 1 to 1. In actual life, this may not be true. Before World War II, the relation between the Bureau of Labor Statistics index of all commodity prices at wholesale, and the index of prices received by farmers, for example, was not 1 to 1, but 1 to 1.5.

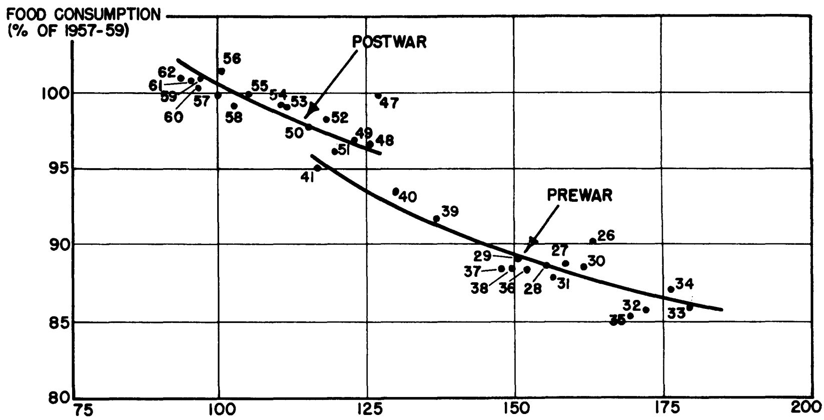

Fig. 8.1 — Food consumption per capita related to deflated food price. (Source: F. V. Waugh "Demand and Price Analysis," USDA, Tech. Bul. No. 1316, 1964, p. 13.)

If, however, a "deflator" can be found which has approximately a 1 to 1 relationship to the price of the good in question, the deflating procedure can help the investigator reveal relationships in simple two-dimensional charts, where otherwise the relationships might be obscured by the use of more complicated methods.

Fred Waugh makes a useful comment on this point. He says, "Of course, we may not always want a deflator with a 1 to 1 relationship to the variable we are studying. It all depends upon the purpose of deflation. If we want to measure the trend in 'real' income, we should divide by some index of retail prices—even though incomes may have risen much more than prices. But when we are deflating for the purpose of holding the demand curve still, (so that we can find simple two-dimensional relationships between deflated price and consumption, for example) then a 1 to 1 relationship is needed."[1]

DEMAND CURVE FOR FOOD

Figure 8.1 is a case in point. It shows the index of the price of food at retail in the United States deflated by the index of disposable income per capita, plotted against the index of food consumption per capita, over the period from 1926 to 1962. The data are given in Table 8.1. The data for the war years, 1942 to 1946, were affected by

[1] Letter to author from F. V. Waugh, Nov. 29, 1963. The analysis in this chapter owes much to Waugh's work, especially "Demand and Price Analysis," USDA, Tech. Bul. No. 1316, 1964.

TABLE 8.1

Food Consumption Related to Prices and Incomes*
(Indexes: 1957–59 = 100)

Year	Retail Food Price†	Disposable Income Per Capita‡	Ratio of Food Prices to Income	Food Consumption Per Capita§
1926	57.6	35.3	163.2	90.1
1927	55.5	35.0	158.6	88.9
1928	54.9	35.4	155.1	88.9
1929	55.6	37.0	150.3	89.1
1930	52.9	32.7	161.8	88.7
1931	43.6	27.9	156.3	88.0
1932	36.3	21.1	172.0	85.9
1933	35.3	19.7	179.2	86.0
1934	39.3	22.3	176.2	87.1
1935	42.1	24.9	169.1	85.4
1936	42.5	28.0	151.8	88.5
1937	44.2	29.9	147.8	88.4
1938	41.0	27.4	149.6	88.6
1939	39.9	29.2	136.6	91.7
1940	40.5	31.2	129.8	93.3
1941	44.2	37.8	116.9	95.1
World War II years excluded				
1947	81.3	64.0	127.0	99.9
1948	88.2	70.0	126.0	96.7
1949	84.7	68.9	122.9	96.7
1950	85.8	74.2	115.6	98.0
1951	95.4	80.0	119.2	96.1
1952	97.1	82.4	117.8	98.1
1953	95.6	85.8	111.4	99.1
1954	95.4	85.8	111.2	99.1
1955	94.0	90.0	104.4	99.8
1956	94.7	94.4	100.3	101.5
1957	97.8	97.8	100.0	99.9
1958	101.9	99.0	102.9	99.1
1959	100.3	103.2	97.2	101.0
1960	101.4	104.9	96.7	100.7
1961	102.9	107.3	95.6	100.8
1962	103.5	110.9	93.3	101.0

* Source: F. V. Waugh, "Demand and Price Analysis," USDA, Tech. Bul. No. 1316, 1964.

† BLS, food component of the CPI (not deflated).

‡ Commerce, income after taxes (not deflated).

§ Agriculture, retail price-weighted index.

price controls and rationing, and are omitted from the table and chart. The deflating procedure is fairly well justified in this case, because the relation between the price series and the deflator is reasonably close to 1 to 1.

The dots for the years from 1926 through 1941 are clustered fairly closely around the line marked "prewar," and the dots for the years from 1948 through 1962 are clustered around the line marked "postwar" (the year 1947 was affected by a holdover of the strong wartime demand). The two lines were fitted freehand.

A benefit from the use of the deflating procedure is evident in the chart; it reveals the discontinuity in the position and elasticity of the curve after the war. Before the war, the elasticity was about —0.25; after the war, it decreased to about —0.17.

DEMAND CURVE FOR VARIOUS MEATS

The usefulness of the deflating procedure, and some of its dangers, can also be illustrated by analyses that have been made of the demand for various meats.

In Section A of Figure 8.2, the United States average retail price of pork, deflated by the CPI (Consumer Price Index) is plotted against United States pork consumption, annually from 1948 to 1962. The data are given in Table 8.2. The correlation is negative, but it is only moderately high.

In Section B of Figure 8.2, the retail price of beef is similarly plotted against beef consumption. The correlation in this case is low, and the relation appears unduly elastic.

Close examination of the beef chart shows that one reason for the low correlation is that the dots drift to the right with the passage

TABLE 8.2

PORK AND BEEF, TOTAL U.S. CONSUMPTION, 1948–62 *

Year	Pork	Beef
1948	9,840	9,163
1949	9,991	9,439
1950	10,390	9,529
1951	10,857	8,472
1952	11,112	9,548
1953	9,900	12,113
1954	9,549	12,743
1955	10,833	13,313
1956	11,125	14,121
1957	10,297	14,242
1958	10,325	13,786
1959	11,797	14,202
1960	11,564	15,121
1961	11,229	15,871
1962	11,685	16,303
1963†	12,049	17,666

* Source: F. V. Waugh, letter to the author.
† Preliminary.

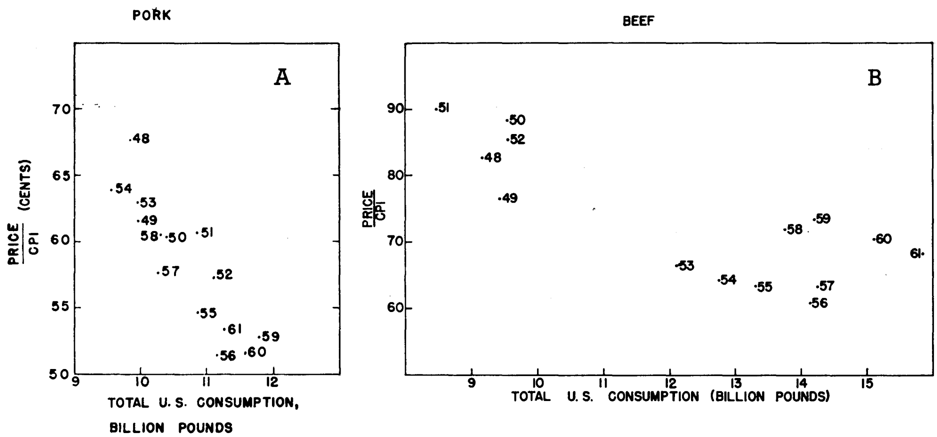

Fig. 8.2 — Section **A**, United States average deflated retail price of pork plotted against United States total consumption of pork; Section **B**, United States average deflated retail price of beef plotted against United States total consumption of beef.

of time. If the influence of the passage of time could be removed, or taken into account in some way, perhaps the net relation between beef price and quantity could be shown more clearly.

But it is not time itself that affects economic series. Something that changes with the passage of time does it. What is needed, therefore, is to isolate the factor affecting the quantity of beef consumed which is changed by the passage of time, and take that factor into account rather than time itself. This need is the more true here, since in the pork chart, no drift either to right or left is discernible. Perhaps two factors associated with the passage of time were working in opposite directions so that they nullified each other. Both factors need to be isolated and measured.

What might these two factors be?

At this point, we are like physicists, trying to determine whether light is given off in waves or in chunks, or "quanta" as the physicist would say. For two likely factors in our case, both associated with the passage of time, come immediately to mind: Total United States population and total United States income.

Of these two factors, total United States population appears as the one that could best be used as a deflator for the United States consumption data—to reduce total consumption to per capita consumption—because the relation between total consumption and total population is clearly 1 to 1. Other things being equal, if total population increased 10 per cent, we would expect total consumption to increase 10 per cent too. But the relation between food consumption and income is less than 1 to 1, as Engels showed many years ago.

So we will choose population, and deflate the total pork and beef consumption data by dividing them by the population, to convert them to per capita form.

This division of United States pork and beef consumption by population has been done before. In a report published in 1954, the present author *et al.* divided the price of pork at retail by the corresponding per capita disposable income, annually from 1925 to 1962, and plotted it against per capita pork consumption.[2] The dots in that chart (not shown here) clustered about two different lines, one for the years from 1925 to 1934, and another, about 20 per cent below and to the left of the first line, for the years from 1935 to 1952; this indicated that the demand curve had shifted downward suddenly from the one period to the other.

A similar chart for beef also showed the dots clustered about two different lines, but in this case the break came during World War II, and the demand curve shifted *upward*, not downward as in the case of pork.

A few years later, the present author added the data for 1953–55 to the pork chart, and found that those dots clustered around a third curve below and to the left of the second.[3] Then Fred Waugh added the data for another year, 1956.[4] It fell right on the third curve. This indicated that the per capita demand for pork had declined again, in a single jump as before. The corresponding chart for beef, however, showed no further increase in the demand for beef.

These studies both suffered from one shortcoming. Division of the price series by disposable income implied that the relation between changes in consumer income and changes in retail prices for pork and beef was 1 to 1. This appears to conflict with Engel's law, which states that expenditures for food change less than incomes change.

The effect of the ratio between income and price being less than 1 to 1 would be that the dots for the later years when incomes were high would be low in relation to the dots for the earlier years when incomes were low. And this would reflect, not a decline in the demand for pork, but only the operation of Engel's law, which would cause a relative decline in the demand for food as a whole.

[2] Geoffrey S. Shepherd, J. C. Purcell, and L. V. Manderscheid, "Economic Analysis of Trends in Beef Cattle and Hog Prices," Iowa State Univ., Agr. Exp. Sta. Res. Bul. 405, Ames, Jan. 1954, p. 737.
[3] See the fourth (1957) edition of the present book, p. 133.
[4] F. V. Waugh, "Graphic Analysis in Agricultural Economics," Agr. Handbook No. 128, USDA, July 1957, p. 31.

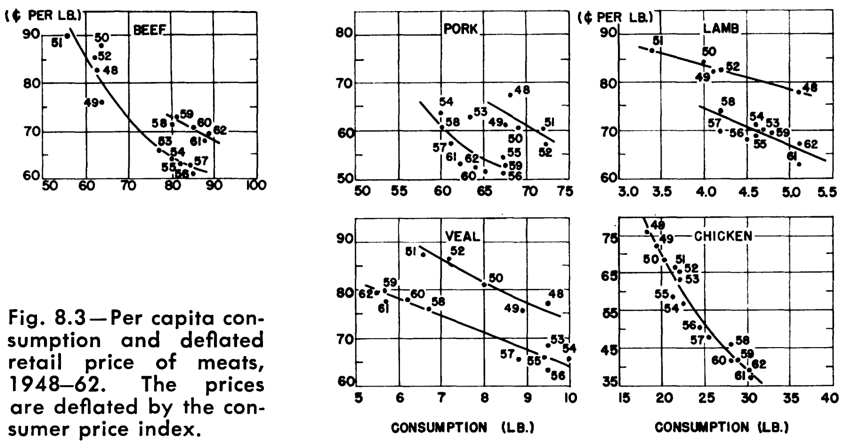

Fig. 8.3—Per capita consumption and deflated retail price of meats, 1948–62. The prices are deflated by the consumer price index.

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PRICES DEFLATED BY THE CPI

In view of considerations like these, Waugh made another graphic analysis after the lapse of a few more years.[5] In this analysis, he divided the price data, not by per capita incomes, but by the Consumer Price Index. He also added the data for additional years, and left out the data for the period before and during World War II. He included data for several other meats as well as for pork and beef. His chart is reproduced here in Figure 8.3, with the data given in Table 8.3.

The dots in the pork section of this chart clustered about two different lines, as in the earlier analyses. This indicated that the demand for pork declined, suddenly, from 1952 to 1954.

The dots in the beef section of the figure fell about two different lines, again as in the earlier analyses. This indicated that the demand for beef increased at one jump, from 1957 to 1958, and remained high thereafter.

Waugh pointed out that this sudden increase in the demand for beef from 1957 to 1958 did not explain the sudden decrease in the demand for pork from 1952 to 1954. The two dates were quite different. The reasons for the sudden shifts in the positions of the two demand curves remained obscure.

[5] F. V. Waugh, "Demand and Price Analysis," USDA, Tech. Bul. No. 1316, 1964, p. 41.

TABLE 8.3

RETAIL PRICES (p) DIVIDED BY CPI, WITH INDEX 1957–59 = 100 AND PER CAPITA CONSUMPTION (q) GIVEN IN LBS. CARCASS WEIGHT*

Year	Beef		Pork		Lamb		Veal		Chicken	
	q	p	q	p	q	p	q	p	q	p
1948.....	63.1	82.9	67.8	67.6	5.1	77.8	9.5	77.1	18.3	75.4
1949.....	63.9	76.3	67.7	61.5	4.1	82.4	8.9	75.7	19.6	71.8
1950.....	63.4	88.3	69.2	60.4	4.0	84.2	8.0	81.1	20.6	68.0
1951.....	56.1	90.0	71.9	60.6	3.4	86.7	6.6	87.6	21.7	66.0
1952.....	62.2	85.4	72.4	57.3	4.2	86.2	7.2	86.3	22.1	65.0
1953.....	77.6	66.2	63.5	62.9	4.7	70.0	9.5	68.7	21.9	62.8
1954.....	80.1	64.1	60.0	63.7	4.6	71.0	10.0	65.8	22.8	56.4
1955.....	82.0	63.2	66.8	54.6	4.6	69.0	9.4	65.8	21.3	58.7
1956.....	85.4	60.9	67.3	51.4	4.5	68.3	9.5	63.6	24.4	50.4
1957.....	84.6	63.1	61.1	57.6	4.2	69.9	8.8	65.5	25.5	47.6
1958.....	80.5	72.0	60.2	60.5	4.2	74.1	6.7	76.1	28.2	45.8
1959.....	81.4	73.3	67.6	52.8	4.8	69.6	5.7	79.8	28.9	41.4
1960.....	85.2	70.4	65.2	51.6	4.8	67.6	6.2	77.8	28.2	41.4
1961.....	88.0	68.3	62.2	53.3	5.1	63.3	5.7	77.3	30.3	37.0
1962.....	89.1	69.8	64.0	52.9	5.1	67.1	5.5	79.5	30.2	38.6

* Source: F. V. Waugh, "Demand and Price Analysis," USDA, Tech. Bul. No. 1316, 1964, p. 39.

REASONS FOR CHANGES IN PER CAPITA DEMAND FOR PORK

The sudden decrease in the per capita demand for pork from 1952 to 1953 and from 1953 to 1954 shown in the pork section of Figure 8.3 cannot be explained by a sudden increase in the per capita demand for beef, for that increase came at a different time—from 1957 to 1958. But further analysis shows that most of it can be explained by changes that took place in the per capita production and therefore *consumption* of beef. This analysis goes beyond Waugh's work.

The beef section of Figure 8.3 shows that from 1952 to 1953, beef *consumption* suddenly increased 23 per cent, from 62.2 pounds to 77.6 pounds; after 1953, consumption continued to increase, although more slowly. This increase in consumption resulted from an increase in the supply of beef; the supply curve moved to the right. The increase in consumption was not initiated by consumers; they merely reacted to an increase initiated by producers. This increase in production, causing an increase in consumption, explains most of the sudden decline in the demand for pork from 1952 to 1954, and the continued but slower decline thereafter. Consumers found beef suddenly more plentiful and cheap than before. They bought and ate more of it. They had less room left for pork; their demand for pork suddenly decreased.

This increase in beef production and consumption also explains the sudden decline that took place in the demand for veal, and for lamb, shown in the veal and lamb sections of Figure 8.3. Even the demand for chicken shown in the chicken section declined to a small extent at that time; thereafter, increasing production of chicken merely cut the stationary demand curve for chicken at lower points.

The sudden decrease in the demand for pork from 1952 to 1953 and 1954, then, can be explained by the sudden increase that took place in beef production and consumption at that time. But after 1954, the demand for pork continued to decline, more slowly than before, but more steadily. How can this slow and steady decline in the demand for pork be explained?

The decline from 1954 to 1956 can be explained by a further increase in beef production and consumption that took place, slowly but steadily, from 1954 to 1956.

After 1956, however, beef production and consumption declined for two years, and the demand for beef suddenly increased. The pork section of Figure 8.3 shows that during those years, the demand for pork ceased to decline and even increased a little. The changes in beef could logically be considered the reason for these changes in pork.

Still later, after 1958, the production and consumption of beef began to increase again. Correspondingly, the demand for pork began to resume its decline. The increase in beef production and consumption could logically be the cause of the decline in the demand for pork in this case, as in the earlier years from 1952 to 1954.

This analysis is given some statistical confirmation in Figure 8.4. Section A of this figure is the same as the pork chart in Figure 8.3, but one single line is drawn in instead of two. (The short dashed lines are explained later.) The residuals (the vertical deviations of the dots above or below the single line) from this chart are plotted against beef consumption in Section B of Figure 8.4. The dots fall fairly closely about a negatively sloping line. The procedure of plotting residuals is explained in the next chapter.

Probably the steady increase in the production and consumption of chicken shown in the chicken section of Figure 8.3 also contributed to the steady decline in the demand for pork. Some of the influence ascribed to beef in Figure 8.4 may really have been due to chicken. The increase in the production and consumption of chicken, resulting from an increase in the supply of chicken (a

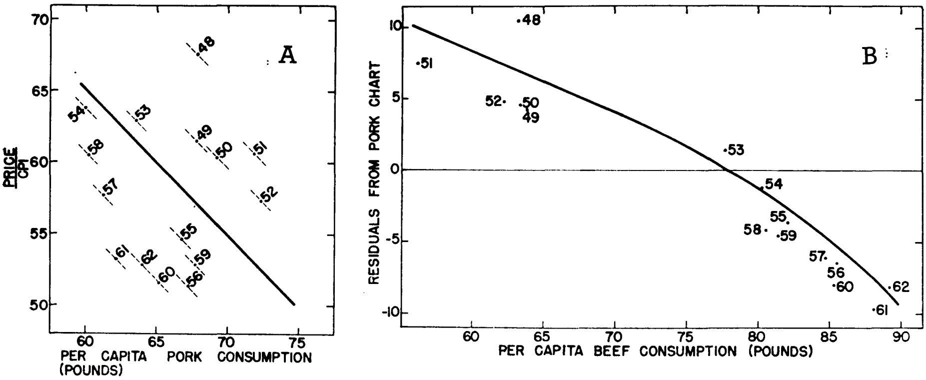

Fig. 8.4 — Section **A**, United States average deflated retail price of pork plotted against United States per capita consumption of pork; Section **B**, Residuals from Section **A** plotted against United States per capita consumption of beef.

movement of the supply curve to the right which resulted from technological improvements in production practices) is correlated to some extent with increases in the supply of beef, so it is difficult to determine empirically and directly how much influence each exerted. But beef is quantitatively about 3 times as important as chicken (consumption is about 3 times as great). It seems reasonable, therefore, to ascribe most of the influence to beef.

The decreases in the demand for pork that took place from 1948 to 1952, with only a slight interruption from 1956 to 1958, therefore, can be reasonably well explained by the changes in the production and consumption of beef and in the demand for beef, and changes in the production and consumption of chicken that took place over that period.

Armed with this information, we can replace the single demand curve in Section A in Figure 8.4 by a succession of demand curves represented by short dashed lines. Each one of these curves is drawn through one of the dots, with the same elasticity as the single curve shown.

These curves move steadily from right to left with the passage of time, with the exception of 1958 and 1959 when the demand for beef increased. This shows more directly and clearly than the pork section of Figure 8.3 how the per capita demand curve for pork moved to the left (the demand decreased) almost continuously over the period.

Thus the decrease in the demand for pork can be regarded as the result of a decrease in consumers' preference for pork. But that is only a superficial view. The basic question is: What caused this decrease in consumers' preference for pork?

The explanation can be found in two objective, measurable changes of a concrete economic nature.

1. The income-elasticities of demand for beef and chicken, as measured in objective economic terms of prices and quantities, are higher than the income-elasticity of the demand for pork. Incomes have been rising, so the demands for beef and for chicken have been rising faster than the demand for pork; this has been one reason for the relative decline in the demand for pork.
2. The second reason is the more important one. It is a production matter. It arises from changes that have taken place in the price and production of beef and chicken. These changes also can be measured objectively in economic terms of costs and quantities. Beef producers have increased their production substantially, with only a small increase in price; their supply curve has been moving to the right. Broiler producers have reduced their costs and increased their production and have sold their product at substantially lower prices; their supply curve has been moving to the right too.

Beef producers and broiler producers have reduced their costs and expanded their production of these other meats; and these more abundant supplies of other meats, selling at lower prices than before, have taken some of the demand for meat away from pork. The problem arises chiefly, not from changes in consumers' tastes, but from reductions in competing producers' costs and increases in their production of competing meats, which have not been matched by reductions in hog production costs and increases in hog production.

REASONS FOR CHANGES IN THE DEMAND FOR BEEF

We are ready now to carry the analysis one step further. The purpose of this further step is to explain the changes in beef and chicken demand and consumption that caused the decrease in the demand for pork.

The increase in the per capita demand (movement to the right of the demand curve) for beef that took place from 1957 to 1958 is shown in the beef section of Figure 8.3.

Why did this increase take place?

Study of the veal section of Figure 8.3 shows that the demand for veal decreased suddenly from 1952 to 1953. This decrease in demand can logically be explained by the sudden increase in beef production and consumption that took place at that time. This was partly a cyclic phenomenon; the beef cattle production cycle rose from a trough in 1951 to a peak in 1956; after 1956 it declined again, although not to as low a level as in 1951.

Further study of the veal section of Figure 8.3 shows that veal consumption decreased drastically from 8.8 pounds in 1957 to only 6.7 pounds in 1958. This is a decline of 24 per cent. It declined still further, although only to a small extent, after 1958.

The beef section of Figure 8.3 shows that this sudden decline in veal consumption came at the same time, 1957 to 1958, when the demand for beef suddenly increased. Perhaps the decline in veal consumption caused the increase in the demand for beef, much as the increase in beef consumption from 1952 to 1953 decreased the demand for pork.

The consumption of veal, however, is only about 10 per cent as great as the consumption of beef. The decrease in veal consumption of 24 per cent could have caused an increase in the demand for beef, at most, of only 2.4 per cent. The actual increase in the demand for beef appears in the beef section of Figure 8.3 to have been about 15 per cent. Now 2.4 is only one-sixth of 15. The decrease in the consumption of veal, therefore, explains only about one-sixth of the sudden increase in the per capita demand for beef.

The bulk of the explanation for the sudden increase in the demand for beef apparently must be sought on the consumer demand side. Yet no very sudden change in consumer demand took place from 1957 to 1958.

Per capita disposable income was rising steadily over that period, from an index of 70 (base, 1957–59=100) in 1948 to 110.9 in 1962. If these figures are deflated by the CPI to reduce them to real income, they are 83.6 and 105.7. This is a rise of 22.1 index points. Accordingly, a slow and steady increase in the per capita demand for beef should have taken place over the period as a whole.

The elasticity of consumer expenditures for beef with respect to income in 1955 was about 0.4; the elasticity of consumption, in pounds, was about 0.2. The elasticity of expenditures for pork was only about 0.2, and the elasticity of consumption was in fact slightly negative.

The slow and steady rise in per capita income over the period, therefore, should have caused a slow and steady rise in the demand for beef, about 0.4 per cent as great as the rise in income. This rise in income was about 22 index points. The demand for beef, as measured by expenditures for beef at retail, would be expected to increase about $22 \times 0.4 = 8.8$ per cent.

But this increase of 8.8 per cent in the per capita demand for beef took place slowly and steadily over the whole period, as income rose slowly and steadily over the whole period. How then can income explain the sudden increase in the demand for beef from 1957 to 1958?

The sudden increase in the demand for beef can be explained by the slow and steady rise in income if one of the assumptions used in the preceding analysis is changed. The assumption to be changed is that the increase in the demand for beef can be represented by the two lines drawn through the two groups of dots in the beef section of Figure 8.3 with the sudden jump from one to the other from 1957 to 1958.

Close study of the chart indicates that this assumption may be unrealistic. The two groups of dots in the chart may not lie on two demand curves with the elasticities shown; they may only connect the intersection points of a series of different demand curves with a series of different supply curves.

What would be the elasticity of these demand curves?

Inspection of the chart shows that if the series of demand curves had lower elasticities than those of the two curves shown on the chart, they would move slowly and steadily across the chart from left to right. That would indicate that the demand increased steadily over the period, in line with the steady increase in consumer income over the period.

This hypothesis is given some statistical support in Section A of Figure 8.5. This chart is the same as the beef section of Figure 8.3, but one single line is drawn in instead of two, and the single line is less elastic than the two lines. The residuals from this single line are plotted against per capita incomes in Section B of Figure 8.5. Here the residuals for all the years but 1950, when the Korean conflict began, fall closely about a positively sloping line, leaving only a small amount of scatter. Most of this scatter can be explained by the sudden decline in veal consumption from 1957 to 1958.

The increase in the per capita demand for beef over the period, then, can be almost completely explained by the increase in per capita income over the period and the sudden decrease in the consumption of veal from 1957 to 1958.

The increase in demand for beef, like the decrease in demand for pork, did not reflect a vague or mysterious change in consumers tastes or preferences. It reflected only quantitative and measurable changes resulting from the increase that took place in consumer incomes, and from changes in the consumption of competing meats. The effect of a change in income is a familiar phenomenon, well doc-

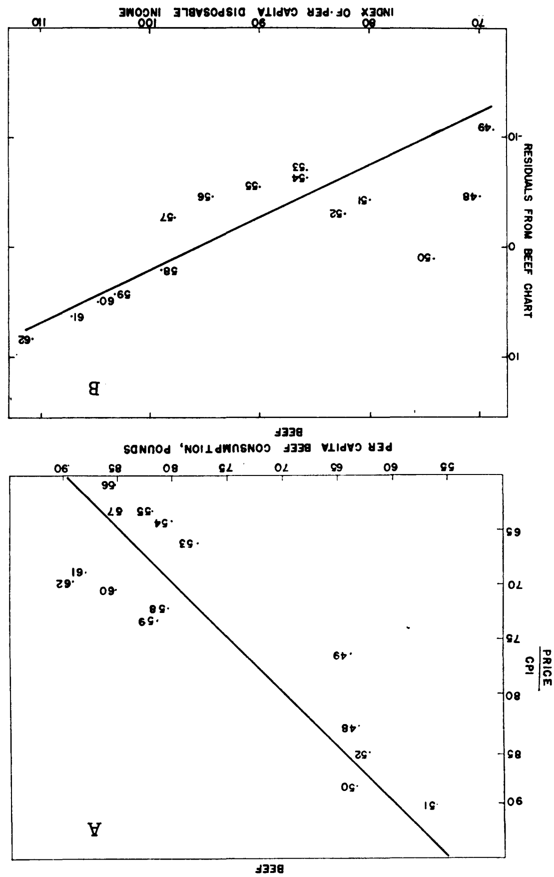

Fig. 8.5—Section A, United States average deflated retail price of beef plotted against United States per capita consumption of beef; Section B, Residuals from Section A plotted against United States per capita disposable income.

umented in previous analyses based on consumer income and expenditure surveys, such as the USDA consumer surveys of 1942, 1948, 1955, and 1965.

This makes it relatively easy, not only to explain the increase in the demand for beef that took place in the past in quantitative terms, but also to forecast what can be expected in the future. So long as per capita incomes continue to increase, the demand for beef can be expected to increase, at a rate about 0.4 times as great as the increase in incomes.

Furthermore, this rate of increase (0.4 as much as the increase in incomes) can be expected to hold for the considerable increase in incomes that is likely to occur in the forseeable future. The line in Section B of Figure 8.5 showing the relation between income and expenditures for beef shows no tendency to level off at the higher incomes, even above $10,000 per year.