7

The Measurement of Changes in Demand and Supply

The demand curve for potatoes portrayed in Chapter 4 clearly shows how a large crop of potatoes depresses the price of potatoes, and a short crop raises it. It shows how the large crop of 1935, for example, depressed the price of potatoes to 90 cents per bushel, and the short crop of 1936 raised the price to $1.40.

Exactly what was the change that took place from 1935 to 1936? We know that prices change in response to changes in demand, or supply, or both. In this case, did the demand decrease, increase, or remain constant? And what about the supply?

Looking at the small crop in 1936 one might say that the price rose and cut off part of the demand; that is, demand decreased. But looking at the high price, one might say that the demand must have *increased.* Which is right?

As a matter of fact, both of these statements would be wrong, for demand is the whole series of prices at which different quantities can be sold (or, the whole series of quantities that can be sold at different prices). The series of prices at which different quantities of potatoes can be sold was shown in Table 4.1. This whole table shows the demand for potatoes. In graphic terms, the demand is a line or curve, not just a single quantity and price; that is only a point on a demand curve.

The demand for potatoes, then, is the whole series of prices and quantities represented by the demand curve in Figure 4.1. Different-sized crops merely cut the curve at different points. From 1935 to 1936 it may be assumed for our purposes here that the demand did not change at all; only the supply changed; the two different-sized crops simply cut the (stationary) demand curve at two different points.

To some people this concept of demand as a whole series of prices and quantities seems unduly complicated. They ask: "When a large crop comes on the market, why not say simply that the price fell, and that brought more buyers into the market, i. e., increased the demand, which thereupon was great enough to take the large crop off the market? That is, why not simply say that the demand increased in 1935 (when the crop was large) and decreased in 1936 when it was small?"

But you can soon see the difficulties you would get into using this concept of demand. For then you would say that the demand decreased from 1935 to 1936 when prices rose. You would say that the rise in price reduced the demand, or, as some of the earlier elementary textbooks used to say, inaccurately, "Demand varies inversely with price."[1] But that would be a flat contradiction of everyday experience embodied in the elementary law of supply and demand, for everybody knows that a decrease in demand *lowers* prices, and an increase in demand raises prices; we know that demand varies *directly* with price.

WHEN DEMAND CHANGES, THE WHOLE CURVE SHIFTS

The only way to keep from contradicting yourself like this is to recognize that demand is the whole series of prices and quantities, the whole curve, in graphic terms. From 1935 to 1936 the demand remained constant (the curve remained stationary); all that happened was that the supply changed, and cut the demand curve at a different point.

This definition of demand as the whole series of quantities that can be sold at different prices is unequivocal. In the light of this definition, it is clearly inaccurate to say, "The demand is greater than the supply," or less than the supply, or equal to it. Each is a whole series of prices and quantities, which are usually negatively corre-

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[1] ". . . popular thought and usage do not distinguish between demand as the actual quantity of a commodity bought, which 'under given conditions' depends on the price, and the 'given conditions' which determine how much the market will take at any named price. Thus in general usage demand is, as J. S. Mill remarked, both the effect and the cause of price. In scientific usage the term is now defined in the latter sense only. Thus a change in price occurs only when there is a change in sales without a change in price alone. When the reference is to actual quantity bought as a result of a certain price, the term to be used is sales or consumption, but this distinction in terminology is not always carefully observed."—Frank H. Knight, "Demand," *Encyclopaedia of the Social Sciences,* Vol. 5, 1931, p. 69.

Even some rather advanced books on economics use the term demand erroneously. Strangely enough, British writers are the worst sinners in this respect. *See* R. G. D. Allen, *Mathematical Analysis for Economists,* p. 117, where the statement is made, "Since price decreases as demand increases . . ." where the author clearly means output or production, not demand. Similar misuses of the term occur in pp. 254–58. *See also* J. R. Hicks, *Value and Capital,* Oxford, The Clarendon Press, 1939, at numerous points throughout the book.

lated in the case of demand and positively correlated in the case of supply. What is meant by the quotation just given is that the amount demanded at a certain price is greater or less than the amount offered at that price. If the amount demanded at $1.00 is more than the amount supplied at $1.00, some buyers will offer more than $1.00 (say $1.05); no seller then will sell for less than $1.00, so one or two buyers will drop out (the amount demanded at $1.05 is less than the amount demanded at $1.00) and one or two new suppliers will come in (the amount supplied at $1.05 is higher than the amount supplied at $1.00) until a price will be reached somewhere between $1.00 and $1.05, at which the amount demanded will just equal the amount supplied.

A change in demand has taken place only when the whole price or quantity series changes. If some years later than those shown in Table 4.1 you found that the quantities of potatoes given could be sold only at 25 cents per bushel less than the series of prices given in Table 4.1 (that is, if you found that you had to set up a new price series 25 cents per bushel less than the series of prices given in Table 4.1), then you could say that the demand for potatoes had decreased. The whole curve would have shifted downward.[2]

SHIFTS IN DEMAND AND SUPPLY CURVES

It is easy to discover the elasticity of the demand for a product when the demand remains constant and only the supply changes. It is much more difficult, however, when the demand is changing (the demand curve is shifting) as well as the supply. For in that case the intersection points of the shifting demand and supply curves are likely to be scattered all over the chart, and the shifts are mixed up with the elasticity so that it is impossible to measure the elasticity directly.

The sort of price-quantity scatter-diagram the investigator gets out of his figures depends upon the shiftiness or instability of the demand and supply. This can be illustrated by the use of real production and market price data. But during World War II, and in the cold war period since, the demand and supply for most products have been continually shifting, both at once, and in many cases under government controls, so that it is difficult to sort out the effects of the one from the other. Before World War II, however, there was one period when the demand was relatively stable (1921–29) and another when it was very variable (1930–39) and the situation approached "open-market" conditions. Empirical data from

[2] A distinction between vertical and horizontal shifts in demand curves is elaborated in Appendix *A*.

those periods can be plotted directly on simple two-dimensional diagrams to show the behavior of demand and supply curves under different conditions. Four broad classifications of these conditions may be made.

Demand Constant and Supply Fluctuating

In Figure 7.1 the chart on the left shows a typical scatter diagram for an agricultural product when demand remains fairly constant. Changes in the weather, etc., from one year to another cause changes in supply, but if the demand remains fairly constant, the dots will cluster along a line with a negative slope; for each dot is the intersection of the demand and supply curve of that year. If demand remains absolutely constant, the supply curve, shifting back and forth from year to year, leaves its intersection points with the demand curve scattered along a single line; this line is the (stationary) demand curve. If, as is more likely, the demand is not absolutely constant, but changes slightly from one year to another, then the dots will be scattered along a path or band about the average demand curve. A single line drawn along the middle of this pathway will represent the average demand curve closely, if the pathway is narrow.

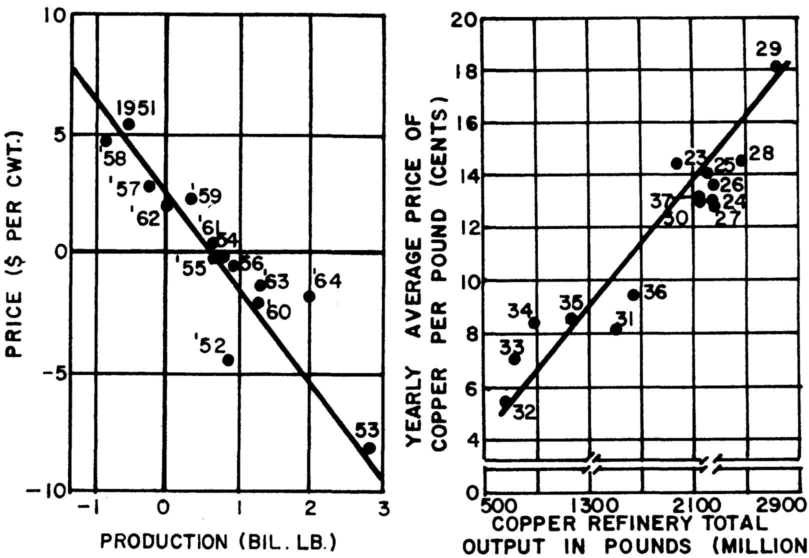

Fig. 7.1 — Chart on the left shows average price of beef cattle, and beef and veal production, first differences, 1950–64 (data from Table 7.1); chart on the right shows average price and total refinery output of copper for 15 years (data from Table 7.2).

TABLE 7.1

CATTLE, UNITED STATES PRODUCTION AND PRICES, 1950–64*

Year	Price of Beef Cattle to Farmers	Beef and Veal Production	First Differences	
			Price	Production
	Dol/cwt	*Bil. lb.*	*Dol/cwt*	*Bil. lb.*
1950......	23.30	9.53		
1951......	28.70	8.84	+5.40	−0.69
1952......	24.30	9.65	−4.40	+0.81
1953......	16.30	12.41	−8.00	+2.76
1954......	16.00	12.96	−0.30	+0.55
1955......	15.60	13.57	−0.40	+0.61
1956......	14.90	14.46	−0.70	+0.89
1957......	17.20	14.20	+2.30	−0.26
1958......	21.90	13.33	+4.70	−0.87
1959......	22.60	13.58	+1.30	+0.25
1960......	20.40	14.73	−2.20	+1.15
1961......	20.20	15.30	−0.20	+0.57
1962......	21.30	15.30	+1.10	0.00
1963......	19.90	16.42	−1.40	+1.12
1964......	18.00	18.42	−1.90	+2.00

* Source: "Livestock and Meat Statistics," USDA, Stat. Bul. 333, July, 1963, and the annual supplement for 1966.

Supply Constant and Demand Fluctuating

The chart on the right in Figure 7.1 shows the reverse situation, found in the case of some industrial products. The relation between production and price here is positive. The supply remains constant or nearly constant, but the demand shifts violently. This sort of diagram used to puzzle the early investigators. Thus Moore, in 1914, finding that the scatter diagram for steel looked like the scatter diagram for copper shown on the right, concluded that the demand curve for steel was positively sloped.[3] But actually what he had found was something approximating the supply curve for steel. Henry Wallace a few years later, pondering over Moore's results, began to grumble about the law of supply and demand. There was one law of supply and demand for farm products, he said—the higher the supply, the lower the price—and another law for industrial products—the higher the supply, the higher the price.

[3] "Our representative crops and representative producers' good (pig iron) exemplify types of demand curves of contrary character. In the one case, as the product increases or decreases the price falls or rises, while, in the other case, the price rises with an increase of the product and falls with its decrease."—Henry L. Moore, *Economic Cycles, Their Law and Cause*, Macmillan, 1914, p. 114.

TABLE 7.2
COPPER, UNITED STATES PRODUCTION AND PRICES, 1923–38*

Year	United States New Copper (Refinery Output) Total	Copper (Electrolytic) New York Yearly Average Price
	Millions of lbs.	*Cents per lb.*
1923	1,980	14.421
1924	2,260	13.024
1925	2,205	14.042
1926	2,322	13.795
1927	2,326	12.920
1928	2,488	14.570
1929	2,740	18.107
1930	2,157	12.982
1931	1,501	8.116
1932	681	5.555
1933	742	7.025
1934	891	8.428
1935	1,178	8.649
1936	1,645	9.474
1937	2,134	13.167
1938	1,585	10.000

* *Statistical Abstract of the United States*, 1939, pp. 728 and 747.

What Wallace had really found was that the two cases illustrated the two parts of the law of supply and demand. Most agricultural products illustrate the one part—that if the demand is constant, the price varies inversely with the supply. Many industrial products illustrate the other part—that if the supply is constant, the price varies directly with demand. The two groups of products are represented by the two sets of conditions shown in both sections. In the one case, the demand remains constant and the supply changes, while in the other, supply remains constant and the demand changes.

Correlated Shifts in Demand and Supply Curves

When the supply and the demand are both changing, the situation is more complicated. The changes in demand and supply may have no relation to each other, or they may be correlated, either positively or negatively. If they are correlated, care must be exercised in interpreting results.

Let us take an extreme case for illustration. The annual price and quantity data for sulfur for an 11-year period are shown in the chart on the left in Figure 7.2. It should be noted that the price and production scales in the chart both run down to zero. The dots show that during this period the production of sulfur changed greatly from year to year, but the price remained absoltuely constant. The data all fall on a horizontal straight line. What does that

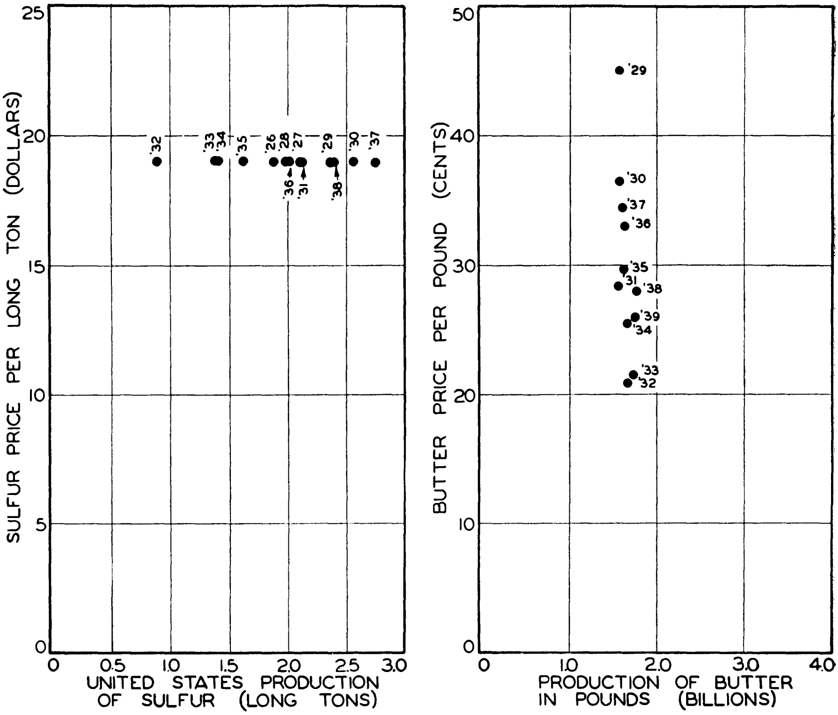

Fig. 7.2 — Chart on the left shows average price and total production of sulfur for an 11-year period; (data from Table 7.3); and on the right, average price and total production of butter, for a similar period (data from Table 7.4).

line represent — a demand curve, a supply curve, or neither one?

The dots almost certainly do not represent a demand curve. It does not seem reasonable that the demand for sulfur would be infinitely elastic over the range shown. It seems very unlikely that consumers would pay as much per ton for sulfur when 2,741,970 tons are offered for sale as when less than a third of that quantity, 890,440 tons, is offered, unless their demand curve shifted its position meanwhile. It must have shifted to the right when larger quantities were offered (or larger quantities must have been offered when the demand curve shifted to the right) and conversely. The dots must represent not a demand curve, but a series of intersections of a negatively sloping demand curve with a supply curve or series of supply curves.

Do the dots therefore represent a supply curve—an infinitely elastic supply curve? This also seems unlikely; but the question should be answered on the basis of a knowledge of the industry rather than any deductive reasoning. It is possible that the industry is a constant cost industry—that all that needs to be done when

TABLE 7.3

SULFUR, UNITED STATES PRODUCTION AND PRICES, 1926–37

Year	Sulfur Produced*	Price†
	Long tons	*Dollars per ton*
1926	1,890,027	18
1927	2,111,618	18
1928	1,981,873	18
1929	2,362,389	18
1930	2,558,981	18
1931	2,128,930	18
1932	890,440	18
1933	1,406,063	18
1934	1,421,473	18
1935	1,632,590	18
1936	2,016,338	18
1937	2,741,970	18

* Production data for 1927 from *The Mineral Resources of the U. S.*, U. S. Bureau of Mines, 1929, Part II, p. 176; for 1928–32, from *The Minerals Yearbook*, U. S. Bureau of Mines, 1932–33, p. 671; for 1933–36, same yearbook, 1937, p. 1303; for 1937, same yearbook, 1939, p. 1245.

† Price data, 1927–37, "The price of sulfur was reduced in 1938—the first change in the quotations since 1926. The price at the mines dropped from $18 to $16 per long ton at the beginning of the last quarter (of 1938)." Quotation taken from *The Minerals Yearbook*, U. S. Bureau of Mines, 1939, pp. 1243–44.

demand increases is (1) to run the plants more shifts per day, the higher labor costs exactly offsetting the lower overhead costs per unit, or else (2) put up new plants with the same costs as the old. However, there is some question about this. Sulfur is produced under oligopolistic conditions, and the stability of its prices probably results from this rather than from cost considerations.

The chart apparently represents a high short-time elasticity of supply, or, what amounts to the same thing, a succession of intersection points of a negatively sloping demand curve with a positively sloping, long-time supply curve, the changes being positively correlated. It should be emphasized that the interpretation of the chart has to rest upon knowledge of the industry and economic reasoning, not merely upon the data themselves.

The opposite situation—a high negative correlation between changes in supply and demand—existed in the case of many agricultural products during the 11 years from 1929 through 1939. The price and production data for butter are plotted in the chart on the right in Figure 7.2. The dots fall closely about a practically vertical line. It is obvious that the elasticity of the demand for butter cannot be practically zero. It is also obvious that the demand for butter declined greatly during the first few years of the depression that began in 1929, and recovered during the latter part. The vertical scatter

TABLE 7.4
BUTTER, UNITED STATES PRODUCTION AND PRICES, 1929–39*

Year	Creamery Butter Produced in Factories	92-Score Creamery New York
	Millions of lbs.	*Cents per lb.*
1929	1,597	45.01
1930	1,595	36.51
1931	1,667	28.31
1932	1,694	21.00
1933	1,763	21.66
1934	1,695	25.70
1935	1,632	29.79
1936	1,629	33.05
1937	1,624	34.39
1938	1,786	27.97
1939	1,759	26.00

* Source of data: *Agricultural Statistics,* USDA, 1940, p. 449.

of the dots, therefore, must represent a series of intersection points of a negatively sloping demand curve with a supply curve or series of supply curves.

Again the question arises—is there a single supply curve, practically a vertical line in this case, or a series of different supply curves? Do the dots all fall about a single supply curve of practically zero elasticity, or do they represent a succession of intersection points with a series of sloping supply curves?

It seems obvious enough that the long-time supply curve for butter must have some positive elasticity. The vertical supply curve shown on the right in Figure 7.2 must show merely the short-time elasticity of supply from plant and equipment already in production and unlikely to be shut down or junked during a short-time decrease in demand. It is a case where a short-time decrease in demand causes a short-time increase in supply; the correlation between changes in demand and supply here is high, and negative.

It goes without saying that most commodities do not fall neatly in one or the other of the classes indicated above—constant demand, constant supply, positive correlation between changes in demand and supply, negative correlation, or no correlation at all. Most commodities fall somewhere along the lines between the several extremes, and care must be taken in the interpretation of all charts and statistical analyses of this character.

The quantity-price curves for many farm products have a negative slope, and it is easy to suppose that they show the demand

TABLE 7.5
HOGS, UNITED STATES PRODUCTION AND PRICES, 1940–60*

Year	Total Hog Slaughter	Slaughter Hog Price
	Thousand head	*Dollars per 100 lbs.*
1940.....	77,610	$ 5.67
1941.....	71,397	9.42
1942.....	78,547	13.57
1943.....	95,226	14.11
1944.....	98,068	13.43
1945.....	71,891	14.55
1946.....	76,021	18.01
1947.....	74,001	24.60
1948.....	70,869	23.56
1949.....	74,997	18.31
1950.....	79,263	18.30
1951.....	85,540	20.24
1952.....	86,572	17.96
1953.....	74,368	21.72
1954.....	71,495	21.72
1955.....	81,051	15.09
1956.....	85,064	14.62
1957.....	78,636	18.02
1958.....	76,822	19.96
1959.....	87,606	14.27
1960.....	84,196	15.73
1961.....	82,057	16.89

* Source: "Livestock and Meat Statistics," Stat. Bul. 230, USDA, Supplement for 1957, p. 103 for 1940–57 slaughter data, and p. 235 for 1940–57 price data. Supplement for 1961, p. 64 for 1955–61 slaughter data, and p. 117 for 1956–61 price data.

curves for those products. Actually, as the charts on the preceding pages show, the curves may have very little relation to demand curves. It is fairly easy to keep from misinterpreting the curves in clear-cut cases like those shown in these charts. It is more difficult in the majority of cases, which lie somewhere between the extremes. Many "demand curves" are not demand curves at all, but only mixtures of demand and supply curves that move with some degree of positive or negative correlation and leave a track of intersection points that represents neither a demand curve nor a supply curve.

This does not mean that such curves are not useful. They may in fact be more useful than demand curves. If changes in demand cause changes in supply, or vice versa, it may be more useful to know what the price-quantity relationship is, under those conditions, than to know what the elasticity of demand or supply is.

A concrete illustration may make this clear. The price-quantity relationship for corn shows an elasticity of —0.65, but the demand curve for corn is probably less elastic than this. A short crop of corn lowers the hog-corn price ratio and leads to a considerable reduction in hog production. This reduces the demand for corn, so that the price of corn rises less than it would if the demand for corn had remained constant. The opposite happens in years of large corn crops; hog production increases—i. e., the demand increases—and this causes prices to fall less than if hog production (the demand for corn) had remained constant. Thus the demand for corn, "other things being equal," is less elastic than the demand for corn, "other things changing as they do when the supply of corn changes." But

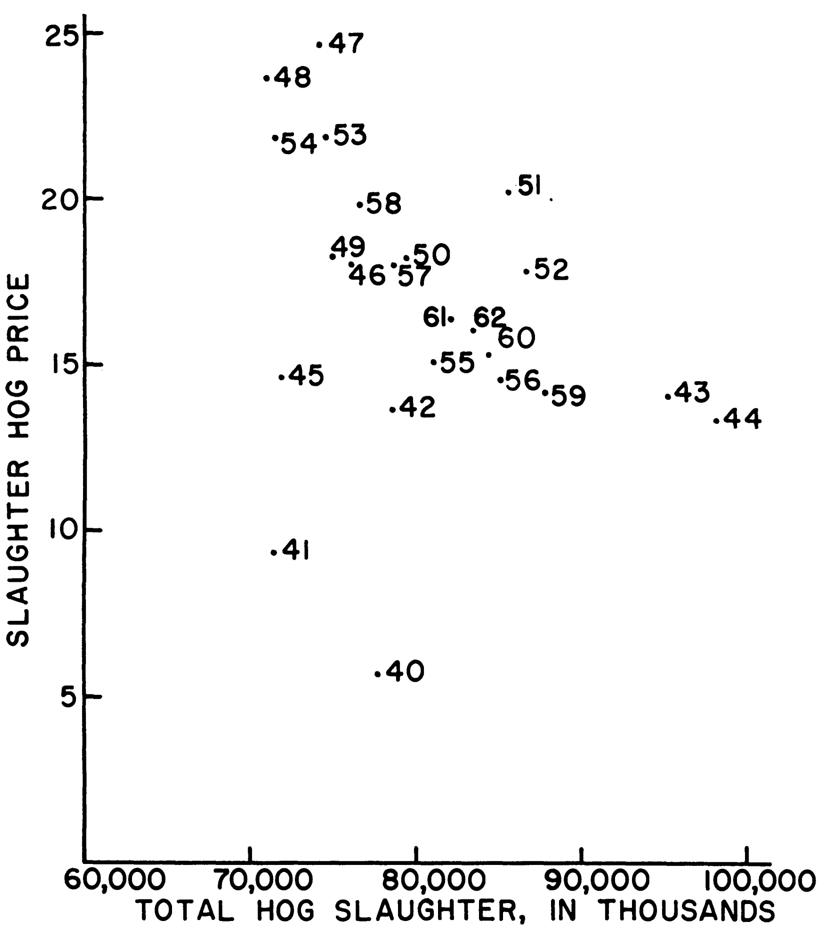

Fig. 7.3 — Relation between weighted average hog prices and total weight of hogs slaughtered, 1940–61 (data from Table 7.5).

it may be more useful to know the elasticity of the latter kind of demand than the former.

Uncorrelated Shifts in Demand and Supply Curves

In many cases, particularly with agricultural goods, the changes in demand and supply are uncorrelated.

This was particularly true during World War II, and has continued to be true during the cold war period that has followed. The demand for most farm products during these war and postwar years has fluctuated violently and sometimes simultaneously. The intersection points of the supply and demand curves for hogs in the United States, for instance, lie scattered all over the page, as shown in Figure 7.3.

When this happens, how can the investigator sort out the shifts in demand from the shifts in supply and determine the elasticities of each? On the face of it, it looks like an impossible job. But methods have been worked out to handle it. They are presented in the next two chapters.