Appendix A

Vertical and Horizontal Shifts in Demand and Supply Curves

There is general agreement among economists that the concept of a change in demand refers to a horizontal shift in the position of the demand curve. This concept conforms with the definition of the elasticity of demand, which refers to the responsiveness of consumption to price.

One might say on the face of it that it doesn't make any difference whether the shift takes place horizontally or vertically. But in actual fact it does make a considerable difference.

A multiple correlation analysis made shortly after World War II showed that the per capita demand for meat relative to disposable income, from 1920 to 1941, declined at a rate sufficient to cause prices to decline over the period as a whole (with per capita consumption statistically held constant) at an average rate of 0.23 cents per pound per year. This was equivalent to a decline of 0.64 per cent per year.[1]

Does this mean that the demand declined 0.64 per cent per year?

If a change in demand is regarded as an upward or downward shift in the demand curve, the answer would be yes. If, however, a change in demand is regarded as a horizontal shift to the left or right, the answer would be that the demand declined less than 0.64 per cent per year. Since the elasticity of the demand for meat is about —0.75, a decline of 0.64 per cent per year in price would

[1] Geoffrey Shepherd, "Changes in the Demand for Meat and Dairy Products in the United States Since 1910," Agr. Exp. Sta., Iowa State Univ. Res. Bul. 368, p. 388.

represent a decline in demand (a shift to the left in the demand curve) of 0.64 × 0.75, or 0.48 per cent per year.

This is a sensible working conclusion, in view of the general agreement concerning the definition of a change in demand as a horizontal shift in the position of the demand curve. But it is interesting and worthwhile to explore the matter further, beyond the present area of agreement, into new and unexplored territory.

FURTHER EXPLORATION

The fundamental idea of vertical and horizontal shifts in demand curves is simple. We can deal with it best by starting with the concept of the demand schedule. A typical demand schedule is shown in column A of Table A.1.

The demand curve D based on these figures is shown in Figure A.1. Both the vertical and horizontal scales in the chart are logarithmic. This preserves parallelism in the curves throughout the various shifts in their position that are considered. The reasoning, however, is independent of the kinds of scales used.

The use of a curved demand line on a logarithmic scale will help to bring out the point more clearly than the use of a straight line, though the reasoning in both cases is the same. Either a concave or a convex curve may be used. We shall start with the former.

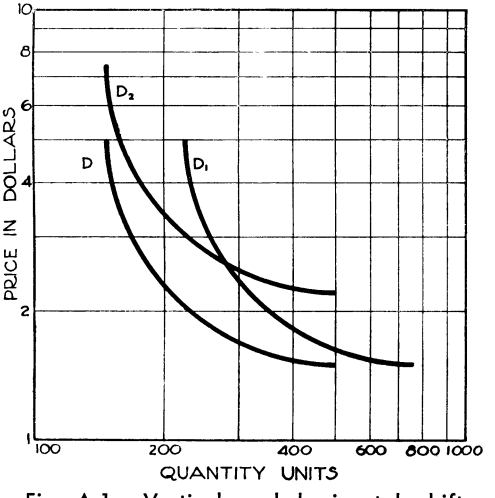

Fig. A.1 — Vertical and horizontal shifts in a concave demand curve.

Suppose, now, that twenty years elapse and the population consuming the good in question increases 50 per cent. If no changes have taken place in the demand per consumer, 50 per cent more goods could now be sold at each price than formerly. The new situation is represented in Table A.1, column B, in which each quantity figure is 50 per cent higher than the corresponding figure in column A. The price figures remain unchanged. The new curve D_1, is shown in Figure A.1.

Now let us suppose that, instead of the population increasing 50

per cent, it had remained unchanged, but the purchasing power of each consumer had increased. No other change in demand took place, but, because of their increased purchasing power, consumers were willing to pay, let us say, 50 per cent more for each quantity than formerly. This situation is shown in Table A. 1, column C, where each price figure is 50 per cent higher than the corresponding figure in column A, the quantity figures remaining unchanged. The new curve, D_2, is shown in Figure A.1.

A concrete illustration of this sort of change in demand is a rise or decline of the general price level. This represents a change in the amounts of money which consumers would offer for the same amounts of goods as before. Another illustration is the effect of the increase in distributors' margins that has been taking place in recent years.

The curve D_1 is an illustration of a horizontal shift in the position of the demand curve. The other curve, D_2, is an illustration of an equal vertical shift. The difference between the two curves seems clear.

EFFECT UPON PRICE PAID AND QUANTITY TAKEN

One might think that a vertical upward shift in the demand curve would result in a higher price being paid for the same quantity of goods as before, and that a shift to the right in the demand curve would result in more goods being sold at the same price as formerly.

TABLE A.1
DEMAND SCHEDULES
(Hypothetical Data)

A. Original Demand Schedule		B. Population Increased 50%, Purchasing Power Unchanged		C. Purchasing Power Increased, Population Unchanged	
Price	Quantity Units	Price	Quantity Units	Price	Quantity Units
$5.00	150	$5.00	225	$7.50	150
4.00	155	4.00	232	6.00	155
3.00	170	3.00	255	4.50	170
2.50	190	2.50	285	3.75	190
2.35	200	2.35	300	3.52	200
2.00	235	2.00	352	3.00	235
1.90	250	1.90	375	2.85	250
1.70	300	1.70	450	2.55	300
1.55	400	1.55	600	2.32	400
1.50	500	1.50	750	2.25	500

Conversely, one might reason backwards from the changes in quantity or price, and say that if the price had increased while the quantity taken remained unchanged, the demand curve must have shifted upwards. But this would be wrong. Production and price simply represent the intersection point of a demand and supply schedule. The effect of a horizontal or of a vertical shift in a demand curve depends upon the supply curve as well as upon the demand curve. Whether a shift in the location of a demand curve, either upwards or to the right, will result in an increase in the price or in the quantity taken, or both, depends upon the conditions of supply; that is, upon the slope of the supply curve and changes in its location.

Under conditions of constant costs, for example, a vertical rise in the demand curve would result in an increase, not in the price for the same quantity, but in the quantity taken at the same price. Conversely, with a fixed stock of a good, a horizontal shift to the right in the demand curve would result, not in an increase in quantity taken at the same price, but in an increased price paid for the same quantity. The nature of the supply curve, and shifts that may have taken place in its location, determines the proportion in which an increase in demand, either upward or to the right, is expressed as an increase in the price or in the quantity taken.

This point is illustrated in Figure A.2. In the left-hand section of this figure, a convex demand curve is shown shifting to the right. The supply curve, however, happens to be inelastic (fixed stock). As a result, although the demand curve has moved to the right, the intersection point of the demand and supply curves has necessarily (because of the inelasticity of the supply curve) moved upward. A higher price is paid for the same quantity as before.

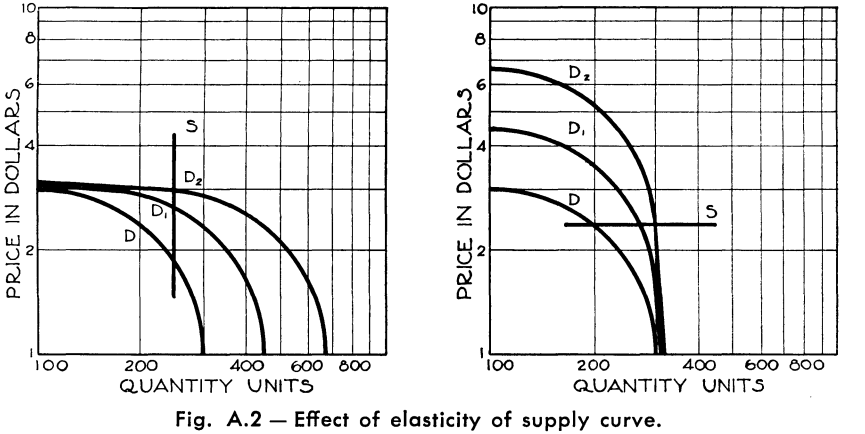

Fig. A.2 — Effect of elasticity of supply curve.

In the right-hand section of Figure A.2, the opposite situation is shown. The demand curve shifts upward, but the supply curve happens to be fully elastic (constant costs). The result of the upward shift in the demand curve is a shift of the intersection point to the right; that is, more goods are taken at the same price as before.

Two things, therefore, are evident. (1) Whenever the demand curve is convex or concave the demand curve as a whole is different in its position after a vertical and after a horizontal shift, and (2) the effect of a shift in demand upon price paid and quantity taken depends, not upon the direction of the shift, but upon the nature of the supply curve.

STRAIGHT-LINE DEMAND CURVES

We come now to the consideration of straight-line demand curves.

Before beginning, we must decide whether we mean straight-line curves on arithmetic paper or on double logarithmic paper. Practically all the statistical price-quantity curves published in recent articles and bulletins are drawn on arithmetic paper. But the concept of changes in demand is fundamentally proportional in character, and changes in demand in actual life are usually[2] proportional. A proportional change in demand shown on arithmetic paper results in a new demand curve that is not parallel with the old. If a proportional change in demand is shown on double logarithmic paper, however, the new demand curve remains parallel with the old. Perhaps the best plan here is to consider separately both arithmetic and logarithmic straight-line demand curves.

Arithmetic Scales

Let us first consider straight-line curves on an arithmetic scale. In this case the difference between the curves resulting from a horizontal and from a vertical shift of 50 per cent is evident, not only when elastic and inelastic curves are used, but also when an intermediate curve with slope of -1 is used. This is shown in Figure A.3. The elasticity of the curves remains unaffected, since the changes in demand are proportional changes, but the slope of the curves is altered.

---

[2] In certain cases a change in demand may be arithmetic. A change in distributors' margins, for example, results in a vertical arithmetic shift.

Logarithmic Scales

If elastic or inelastic straight-line curves on *logarithmic* scales are used, the position of the curve after a 50 per cent upward shift will be different from its position after a 50 per cent shift to the right, and so will the price paid and quantity taken.

It is only in the rare case of a straight-line demand curve on a double logarithmic scale, with a slope of —1 throughout, that the position of the curve would be the same after either shift. In this case the effect of a horizontal shift in demand upon the location of the intersection point, that is, upon production and price, would be identical with that of an equal vertical shift. After population has increased 50 per cent, consumers as a group might either pay higher prices for the same quantity as before, or take larger quantities at the same price as before, or some intermediate combination of the two, according to the nature of the supply curve. If the supply curve were a vertical straight line (fixed stock), the consumers would pay more for the same quantity. If the supply curve were a horizontal line (constant costs), they would take a larger quantity at the same price. If the supply curve had a slope intermediate between vertical and horizontal, the effect on price and quantity would be intermediate—both price and quantity would increase, in proportions determined by the slope of the supply curve.

Reason for Distinction

The reason for distinguishing between vertical and horizontal shifts in demand curves is this: We start with a price series, and find that it fluctuates. What is the reason for the fluctuations? The accepted procedure among economists is to group the possible causes under the two heads: Demand and Supply. Investigating these two groups, we come to the conclusion that the demand changed, or the

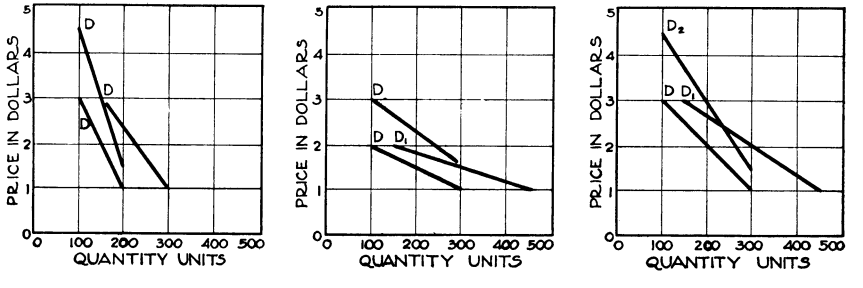

Fig. A.3 — Shifts in straight-line demand curves. Arithmetic scales.

supply changed, or both. If our objective is to reduce price fluctuations in the future, we know then whether we need to concentrate our attention upon changes in demand, or in supply, or in both.

The purpose of the distinction between horizontal and vertical shifts in demand (or supply) curves is to enable us to carry our investigation one step further. We have determined, let us say, that the chief cause of the price fluctuations was the changes that took place in demand. The demand curve shifted, and the question is, which way did it shift—up, down, or sideways, or some combination of these?

This question cannot be answered by observing whether the intersection point *or the range of actual price-experience on the demand curve* (which is merely the range of intersection points) shifted up or sideways. That depends on the nature of the supply curve. The question is answered only by remembering that a demand curve represents demand. Economists define demand as consumers' willingness to buy certain quantities at certain prices; and that willingness exists whether the supply curve has fluctuated enough to reveal it in actual transactions or not. This means that the demand curve extends both ways, beyond the range of past experience in the market—ultimately, until it cuts the vertical and horizontal axes where quantity and price respectively are zero. (The curve will not extend indefinitely; it will cut both axes at some finite points.)[3]

To tell which way the demand curve has shifted, then, is to go behind the original price and quantity data on which the demand curve rests. We are seeking to explain why the data changed. It seems obvious that, if population increased 50 per cent and if no other important change took place, the curve moved to the right, not upwards and to the right. The question can be demonstrated statistically when the demand curve is strongly curved, when, for example, it is a convex curve that cuts both axes at almost right angles, or a sloping straight line that flattens out or gets steeper as either axis is approached; it is equally true, only less obvious, when a straight line is used. We are on logically sounder ground in

[3] Usually these points, like those shown in Figure A.3, will represent prices or quantities not greatly (say 100 per cent) in excess of the highest prices or quantities that have been actually experienced in the market, unless the demand is extremely inelastic, as for salt or water, or extremely elastic, as for human foods that can be fed to livestock if produced in excess. Substitution of other products levels off most demand curves as they approach the vertical axis, and rapidly declining marginal utility with increasing quantity causes most demand curves to cut the horizontal axis at a point not very far out to the right.

endeavoring to carry the explanation of price movements down to its ultimate causes if we recognize that a demand curve may shift either horizontally or vertically, or some combination of both, independent of which way (if any) the intersection point or the range of intersection points moved. We need to investigate what happened to the demand curve first, and then turn to a study of what happened to the supply curve; for movements in demand curves and supply curves (except in a roundabout sense, as during inflation or deflation) are independent of one another.

We are not studying movements in the intersection points of demand and supply curves; if so, we would be studying only movements in production and prices. What we are trying to do is to study the movement of demand and supply curves that lie behind and cause these movements in prices and production. Economic theory has provided the research worker with conceptual tools for analyzing movements in prices and production into changes in demand and supply, that is, into movements of demand and supply curves.

The next step is to analyze these movements into their horizontal and/or vertical components. As data concerning population, incomes, pay rolls, wage rate indexes, general price levels, distributive margins, etc. become more detailed and adequate for analytical purposes, economic analysis is carried this one step further to give these questions a quantitative answer.