APPENDIX A: OTHER THEORETICAL ISSUES IN USING CONSUMER SURPLUS

So far, the consumers' surplus analysis has only considered the demand for a final good, say a clock, or the derived demand for some input, or intermediate good, such as the steel that is used in the manufacture of clocks.

Monopolistic Demand: The appropriate consumers' surplus measure for steel, or steel of a particular kind, is obtained from the correctly derived demand curves for steel. Thus the short run demand curve for steel derived from the clock industry is obtained by subtracting from the marginal valuation of the nth clock the combined cost of all other inputs that enter into the production of this nth clock—assuming the prices of other inputs to be fixed and that all other inputs are combined efficiently.[122] All such derived demand curves for this particular kind of steel can then be added together taking special care not to violate the ceteris paribus assumptions which in this instance requires that we introduce each of the relevant demand curves for the final steel-using products in sequence.

Note, however, that the correctly derived short-run demand curve for steel, arising say, from the demand for clocks, is not always the same as the clock-producer's demand for steel. If the clock-producer is a monopolist who sets output to equate marginal revenue to marginal cost, his demand curve for steel—as for each of his other outputs—will be derived from his marginal revenue curve, and not from the market demand curve for his clocks.

Income Impacts: Beginning from a general equilibrium system, we can deduce that the amount of a good x that is bought depends not only on its own price but on the prices of all other goods and factors, also on tastes, on technical knowledge, and on the distribution of resource endowments. In statistical estimates of the price-demand curve for x, the relationship is much more restricted. We might, for example, try to gather enough data so as to derive a specific equation from the relationship X=F (Px, Py, Pz, M), X being the maximum amount of goods x demanded, Px, Py, Pz being the prices respectively of the goods x, y and z, and M being aggregate real income. Goods y and z could be chosen as being close and important substitutes for x, or else y could be a close substitute and z a close complement of x, the relative prices of all other goods being ignored. Sometimes the prices of one or more factors are to be included in the function. If, for example, the good x is taken as farm tractors, the income of the farm population would obviously be a significant variable in the demand for tractors. In any statistical estimate of the price-demand curve for X, the ceteris paribus clause will operate to hold constant only those variables, other than Px, that are included in the function F. All those variables that are not included in the function F—an almost unlimited number of goods and factor prices—are assumed, provisionally at least, to be of negligible importance.

Although this procedure is fairly general, there has been an issue concerning the interpretation of the M term. If aggregate real income is held constant in constructing this demand curve, we are left with a curve that summarizes the pure substitution effect of, say, a declining price. No income-effects are included, and the measure of consumers' surplus derived there from will be conceptually accurate.[123] If on the other hand, aggregate money

[122] The first order conditions for productive efficiency require that input rates of substitution be inverse to the ratio of input prices. As Marshall points out [14], [26], the elasticity of the derived demand for an intermediate good such as steel varies *inter alia* with the elasticity of substitution between this intermediate good and others, and also with the elasticity of demand for the final goods using the intermediate good.

[123] Moving along a demand curve for which real income is constant entails an unchanged welfare—no shifting, that is, of the marginal valuation curve because of changes in welfare.

income is held constant, any fall in the price of x raised the real value of an unchanged aggregate money income and—if the income effect on x is positive—results in some further increases in the amount of x bought (along with changed in the amounts bought of all other goods).[124] The resultant demand curve is therefore a compound of substitution and income effects. In consequence, the measure of consumers' surplus derived from such a demand curve can be no more than an approximation to the ideal measure based on a pure substitution-effect demand curve, as proposed by Friedman [26]. It will be less accurate according to whether the income effect is more important.

However, the difference that arises from using constant real income, as against constant money income, in the statistical derivation of a demand curve for a single good, is likely to be too slight relative to the usual order of statistical error to make the distinction significant in any cost-benefit study. The emphasis in the ceteris paribus dollar of the market price-demand curve for x is to be placed, instead, on the constancy of prices of goods closely related to x. Thus, the amounts bought of all other goods in the economy, including those of y and z, may alter as they please in response to a decline in the price of x.[125] The measure of the x consumers' surplus is not thereby affected. (Only if alterations take place in the prices of the closely related goods y and z, following a fall or rise in the price of x, does the measure of x's consumers' surplus have to be qualified.) For the area under the demand curve for x is a valid measure of the gain to consumers only when the introduction of x, or a decline in its price, is accompanied by access to all other goods at unchanged prices.

Substitute Goods: Despite the above, there is a strong temptation among those who use consumer surplus to seek an increase in consumer surplus for good x in the consequent shifts of demand for goods related to it. As a result, care should be taken to ensure that in measuring the consumer surplus of a new good, or a good for which the price has changed, that the potential induced shifts of demand of related goods should not be included.

As a result, it is important to emphasize the propriety of ignoring the repercussions on the amount of other goods bought whenever measuring the change in consumer surplus from an alteration in the price of good x above. However, while the impact of a price change for a substitute good should not be incorporated in the measurement of the consumer surplus for a particular good, it does not mean that the consumer surplus related to the substitute good itself should not be measured. For example, assuming provisionally constant costs in the production of all goods in the economy, a fall in the price of x will cause a shift to the left of the ceteris paribus demand curve for good y which is, we assume, an important substitute for x. The now smaller area under this demand curve for y is the consumers' surplus enjoyed from the availability of y, at the unchanged price of y, when the price of x is lower than before. This smaller area of consumers' surplus for y accords with common sense, for with the fall in price of its close substitute x the existing level of welfare will depend less on good y than before. Thus if y were now to be totally withdrawn from the market, the welfare

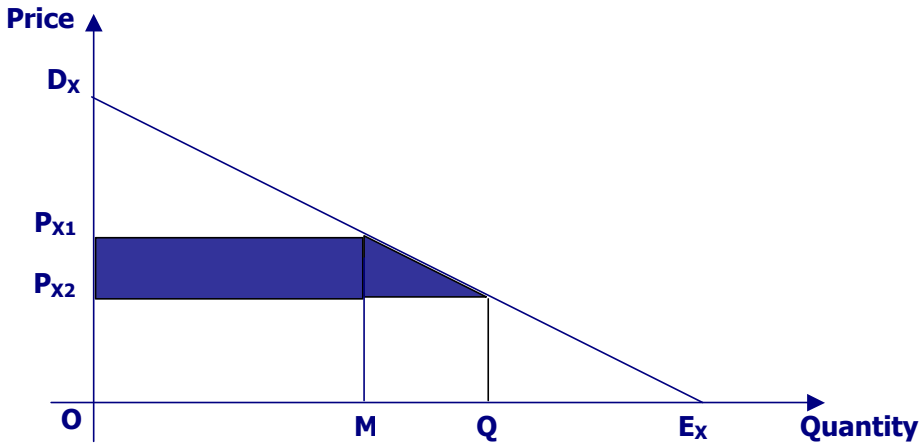
[124] If a person is willing to pay $5 for the first pint of milk per week, and after paying $5 for the first pint is willing to pay $4 for a second pint, then he would be willing to pay more than $4 for the second pint if he did not have to pay as much as $5 for the first pint, but some smaller amount, say $2. For in that case he would be making a consumer's surplus of $3 on the first pint of milk bought, and to the extent that this makes him better off he is willing to pay more (assuming his income-effect with respect to milk is positive) for the second pint.

[125] If the demand curve for x has an elasticity greater than unity the amounts demanded of other goods will fall and (assuming full employment) some of the factors released from the production of these other goods will move into the production of x. If however, the demand for x is of less than unit elasticity, factors will move out of x and into the production of other goods, the demand for which will, on balance, decrease. In the limiting case of unit elasticity of demand for x, there is no change in total cost and total expenditure of x, and no change in total expenditure on all other goods taken together. (More about the role of elasticity in a measurement of economic rent profile change see: [27], [28]).

loss suffered by society would be smaller simply because the substitute x has become available at a lower price than before.

To illustrate, in Exhibits A1 and A2, the initial ceteris paribus demand curve for each good is the solid line. D_xE_x is the demand curve for x when the price of good y is held constant at py. D_YE_y is the demand curve for y when the price of good x is held constant at P_{X1}. If now, as a result of some improved method of production, the price of x falls from P_{X1} to P_{X2} then the demand curve for y falls from D_YE_Y to $D^1_YE^1_Y$ as is shown in Exhibits A1 and A2. At the unchanged price P_Y, the smaller quantity of y, OB, is demanded instead of the quantity OC which was demanded before the fall in the price of x.

Exhibit A1



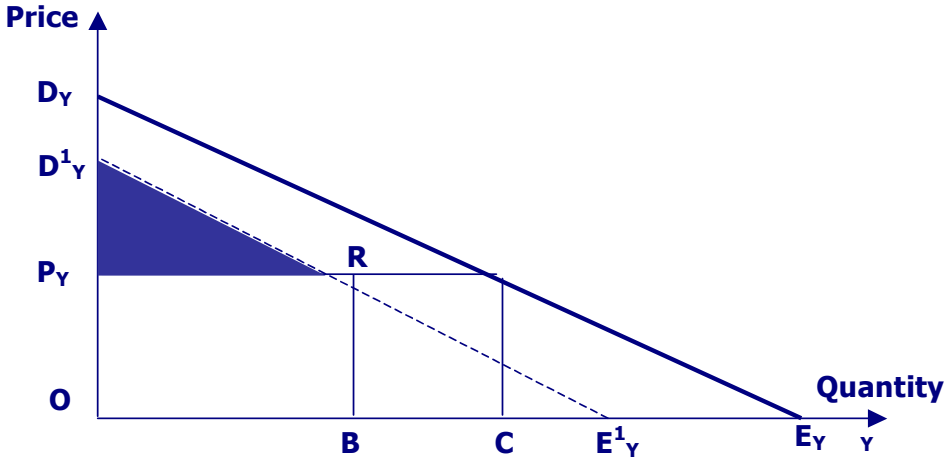
Consumer Surplus When Price of a Good Declines

With a lower price of x consumers are obviously better off. They would, of course, be better off even if they had to buy exactly the same amounts of x and y as they did before the fall in the price of x. But they further improve their welfare by buying more of x and buying less of y. Once they have made these changes in their purchases of x and y, how do we interpret these consumers' surpluses?

First, the measure of the gain in consumers' surplus is represented wholly by the shaded strip in Exhibit A1 between the original price P_{X1} and the new price P_{X2}. Provided all other goods prices remain unchanged—and in particular that of the close substitute y—this shaded strip measures the most that consumers will pay to have the reduction in the price of x.

Second, the triangle $D^1_YRP_Y$ in Exhibit A2 represents the consumers' surplus in having a price P_y when the price of x is now P_{x2}. This triangle is the difference between the most they would pay for OB of y (OD^1_yRB) when x is priced at P_{x2}, and what they have to pay for OB of y (OP_YRB).

Exhibit A2



The Impact on Consumer Surplus when the Price of Substitute Good Declines Causing Shift in Demand Curve

Note particularly the interpretation of this reduced triangle of consumers' surplus—that where the demand curve for y shifts inward in response to a fall in the price of x. The reduction of the initial area of consumers' surplus $P_YD^1_YR$ (corresponding to the lower price of x, P_{X2})—a reduction in area equal to $D^1_YD_YSR$—is not to be regarded as a loss of consumers' surplus consequent upon the fall in the price of x from P_{X1} to P_{X2}. This reduction in area is simply the consequence of consumers' bettering themselves by switching from good y to the new lower-priced good x. Provided supply prices are constant, and we assume they are, the ceteris paribus conditions are met, and the partial analysis depicts the consumers gains wholly within the area of the demand curve of the good the price of which has fallen—irrespective, that is, of the resulting magnitude and direction of the shifts in demand for all other goods in the economy.

It follows that if we are focusing our attention on the consumers' surplus of the good x, and it appears to increase in response to a rise in the price of the substitute good y, this larger area under the demand curve for x is to be interpreted as the maximum amount of money that people are now willing to pay for having x available at its unchanged price when all other prices are given and the price of the substitute good y is higher. To be sure, consumers as a whole are worse off when the price of y alone is raised, but this larger area of consumers' surplus for the good x means that—given all prices, including the now higher price of y—the gain wholly associated with having x available at the same price is, in these circumstances, larger than before.

This proposition can be extended to cover a potential good x, one that can be introduced at a known cost and indeed will be introduced if the demand for it is high enough. Let the existing good continue to rise in price and it will be socially profitable to introduce the good x at a price equal to its marginal cost when, at that price, the consumers' surplus is large enough to cover the capital costs incurred in the production of x.

The economist, examining the future course of the demand curve for x in order to calculate the magnitude of future benefits from its consumption, does not therefore need to distinguish between the rises in consumers' surplus for x that indicates an increase in

society's welfare and the rises in consumers' surplus that are indicative of a loss in social welfare, the result, say, of price rises or unavailability elsewhere in the economy. He accepts as data all the prices and goods over which he has no control, for they fall outside his domain of investigation. If the project is that of investing in an increased output of x, the magnitudes over the future of the consumers' surplus of the increased output of x are to count no matter how they arise.

No exception to this rule occurs if the rise in the price of a good y, or any other good related to x, is a result of direct government intervention. If the government levies an excise tax on y, or adopts a policy of withdrawing y from the market, the economist is always at liberty to point out the lack of economic justification for such policies, and the consequences that are likely to follow from their implementation. But assuming these policies are to prevail over the relevant time period, he has no choice but to measure the changes in the consumers' surpluses of good x in the usual way.

We have stated that in the construction of a demand curve for a good x the appropriate dollar contains all other product prices, all factor prices, tastes, technology, and resource endowments. Since changes in resource endowments can imply changes in distribution or in the size of population, and changes in technology can imply changes in real income per capita, the ceteris paribus clause can be expressed in an alternative form that requires constancy of product prices, population, per capita income, distribution and tastes.

Conclusion: The specific application in this study is of a small change in the transportation cost for the movement of goods and passengers across a regional system. The Ohio Hub passenger rail system is a close substitute (in terms of an individuals travel options) for the use of existing highways, by auto and bus, and for air travel through airports. As a result, there will be only very limited income effects, with only marginally adjustments to the overall demand curve for travel. As such the application of this technique will be within the limits of its applicability.