Cross-Price Elasticity and Income Elasticity of Demand: Are Your Students Confused?

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CROSS PRICE ELASTICITY AND INCOME ELASTICITY OF DEMAND: ARE YOUR STUDENTS CONFUSED?

by Philip E. Graves* and Robert L. Sexton**

Abstract

The authors demonstrate that most textbooks are ambiguous at best in their treatment of cross price and income elasticity of demand. There is also no discussion of what initiates a price increase in discussions of substitutes and complements in the textbooks examined. The authors offer a remedy for these deficiencies.

Introduction

We examined a large sampling of top selling microeconomics textbooks (principles and intermediate): Arnold (2008), Baumol and Blinder (2009), Besanko and Braeutigam (2008), Case and Fair (2004), Frank and Bernanke (2007), Hall and Lieberman (2008), Hubbard and O’Brien (2008), Pindyck and Rubinfeld (2005), Lipsey, Ragan and Storfer (2008), Mankiw (2007), McConnell and Brue (2008), Miller (2008) and Parkin (2008), Perloff (2009), Sexton (2008) and Schiller (pp. 404–07). In each of these texts, in the chapter on supply and demand, it clearly states that if a decrease (an increase) in the price of one good causes a decrease (an increase) in the demand for another good, buyers view these two goods as substitutes. And, if a decrease (an increase) in the price of one good causes an increase (a decrease) in the demand for another good, buyers view these two goods as complements. However, it is also true that in almost every principles and intermediate economics textbook the definition of cross price elasticity is written as follows: the percentage change in the quantity demanded for a good that results from a given percentage change in the price of another good. The problem is the use (or abuse) of the terms demand and quantity demanded. In one chapter, students are taught that substitutes and complements are the relationship between the price of one good and the demand for another and now in a different chapter they are taught that substitutes and complements are the relationship between the price of one good and the quantity demanded for another, without explanation. McEachern (2009) was the only text that we surveyed that was correct.

Of course, the problem stems from economists employing convenient two-dimensional graphs to describe n-dimensional phenomena. The problem disappears in more advanced discussions where it is seen that the demand relationship is a mapping from R^n to R^1, and a change in any independent variable causes a change in the dependent variable, desired quantity. Whether one calls this “change in demand” or “change in quantity demanded” is immaterial in the n-dimensional setting. However, at the principles level, and in some intermediate treatments, there is great potential for confusion as we show here.

Cross Price Elasticity of Demand

With regard to cross price elasticities, Pindyck and Rubinfeld (2005, p. 34–35) write, “...the cross price elasticity will be positive because the goods are substitutes: Because they compete in the market, a rise in the price of margarine, which makes butter cheaper relative to margarine, leads to an increase in the quantity demanded (Because the demand curve for butter will shift to the right, the price of the butter will rise). Some goods are complements...If the price of gasoline goes up the quantity of gasoline falls and motorists will drive less. And because the people are driving less, the demand for motor oil also falls (the entire demand curve for motor oil shifts to the left). Thus, the cross price elasticity of motor oil with respect to gasoline is negative.” It is

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clear that students could easily be confused with what they learned in the supply and demand chapter—Pindyck and Rubinfeld (2005, p. 22) write, “... we will use the phrase change in demand to refer to shifts in the demand curve, and reserve the phrase change in quantity demanded to apply to movements along the demand curve. However, they define complements and substitutes to be when a change in the price leads to a change in the quantity demanded. This would suggest to a student that they are saying that there is not a shift in the demand curve when the price of a related good changes. We contend that the failure to consistently use “change in demand” and “change in quantity demanded” is likely to lead to confusion among students.

Besanko and Braeutigam (2008, p. 49) write, “the cross price elasticity of demand for chicken with respect to beef is positive indicates that as the price of beef goes up, the quantity of chicken demanded goes up ... As the price of breakfast cereal goes up consumers will buy less cereal and thus will need less milk to pour on top of their cereal. Consequently, the demand for the milk will fall.” This is likely to be confusing to students because the authors use quantity demanded of chicken (incorrectly) in the substitute example and the demand for milk (correctly) in the complements example.

Lipsey, Ragan and Storer (2008) is the least confusing of the books we examined. They define cross price elasticity as “the responsiveness of demand to changes in the price of another product is called the cross elasticity of demand.” However, then they write the cross price elasticity formula as the percentage change in quantity demanded divided by the percentage change in the price of Good Y. This leads to the same confusion between demand and quantity demanded seen earlier. Why not call it what it is, namely the percentage change in demand? They follow by correctly stating, “The change in the price of good Y causes the demand curve for Good X to shift. If X and Y are substitutes, an increase in the price of Y leads to an increase in the demand for X. If X and Y are complements, an increase in the price of Y leads to a reduction in the demand for X. In either case, we are holding the price of X constant. Therefore, we measure the change in quantity demanded of X at its unchanged price by measuring the shift for the demand curve for X. (authors' bold for emphasis)

See figure 1, where an increase in the price of butter increases the demand for the substitute margarine. We are interested in measuring the percentage shift in the demand curve for margarine, i.e. the difference between $Q_0$ and $Q_1$ divided by $Q_0$.

The important point is that the cross price elasticity of demand is the measurement of the percentage shift in the demand curve for the substitute or complementary good. We need to avoid the usage of the expression “change in quantity demanded” when demand curves are shifting, saving that expression for movements along a demand curve resulting from own-price changes. We propose that the cross price elasticity definition be written as the impact the price of one good will have on the demand for another good in percentages, other things equal.

**Income Elasticity of Demand**

The same problem occurs with income elasticity for all the authors cited above. For example, McConnell (2008) in the supply and demand chapter writes, “for most products a rise in income causes an increase in demand.” This is the normal good scenario seen in every principles text. Goods whose demand varies inversely with money income are called inferior goods. However, moving to the chapter on elasticity McConnell writes, “normal and inferior goods are defined as the percentage change in quantity demanded divided by the percentage change in income.” Again, we see a potentially
confusing failure to distinguish between demand and quantity demanded. Consistent usage would require that the income elasticity of demand be defined as the responsiveness of the change in demand to a change in income in percentage terms.

What Caused the Price Increase?

There is another source of possible confusion that the formal definition may pose to students if the cause of the initial price increase is not specified.

For example, assume that peanut butter and jelly are complementary goods. This would mean that a change in the price of peanut butter would be inversely related to a change in demand for jelly. The logic could seem straightforward—a result of a higher price for peanut butter fewer people will purchase peanut butter and consequently there would be less demand for jelly. This would hold true if the price increase in peanut butter was caused by a supply shift. However, this would not necessarily be the case if the increase in the price of peanut butter was caused by an increase in demand. If the higher price of peanut butter was demand induced, say a new medical discovery that peanut butter was a longevity enhancing substance; then the outcome would be a larger quantity of peanut butter bought at the higher price and hence, a greater demand for jelly. And, if a decrease in demand for peanut butter, a medical discovery that many people now realize they are actually allergic to peanuts would cause the demand curve for peanut butter to fall and as the price for peanut butter fell there would be fewer jars of peanut butter purchased and therefore a lower, not higher demand for jelly.

The same caution is also relevant for substitute goods. If, for example, Chevron gas and Shell gas are substitutes, then one would expect to see an increase in the relative price of Chevron to lead to an increase in demand for Shell. This would, of course, be true if the increase in the price was caused by a reduction in the supply curve of Chevron. If, on the other hand, the demand for Chevron increased, say through effective advertising—say a new improved cleaner burning fuel, and this caused the price increase; the quantity of Chevron would actually increase and hence customers would be substituting away from the other product, Shell. Alternatively, if the price of Chevron fell, the student would be led to believe that there would be a reduction in demand for Shell. However, if demand fell for Chevron, the price and quantity of Chevron would fall, implying that there would now be less of Chevron and presumably more of Shell purchased despite the lower relative price of the substitute.

Conclusion

In discussions of substitutes and complements and of cross price and income elasticities—both in class and on exams—it is important to inform students to consistently employ “change in demand” (supply) and “change in quantity demanded” in all contexts/chapters. The additional time spent here will lead to greater clarity and much less student confusion in the application of supply and demand.

References
