INTEGRATING THE OUTPUT AND SUBSTITUTION EFFECTS OF PRODUCTION INTO THE INTERMEDIATE MICROECONOMICS TEXTBOOK

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ABSTRACT

Intermediate microeconomics textbooks employ indifference curve analysis to explain the income and substitution effects of a change in the price of a good x on the demand for it, holding other variables constant. Further, they demonstrate how the shape and slope of the demand curve changes depending on whether good x is defined as normal, inferior, or Giffen. This analysis in turn enables an evaluation of public policies aimed to increase consumer welfare. Unfortunately, these textbooks do not apply a parallel analysis in production theory, creating an analytical vacuum at the undergraduate level. This paper develops a model to analyze the output and substitution effects in production when the price of one input (labor) changes, holding technology, resource availability, and the price of the other input constant. This study will also address the production equivalents of normal, inferior, and possibly Giffen inputs affecting the shape and slope of the input demand curve. Such an exercise may allow students to gain a better understanding of producer and consumer theories, and encourage them to employ these concepts to real economic problems such as the effect of wage subsidies on labor demand. It should therefore be included in intermediate microeconomics textbooks.

JEL: A22, D11, D24

KEYWORDS: Substitution Effect, Output Effect, Isoquants, Consumer Theory, Producer Theory

INTRODUCTION

Every intermediate microeconomics textbook devotes substantial attention to the income and substitution effects of a change in the price of a good on a consumer's demand for that good using indifference curve analysis. The good in question may be defined as a normal good, an inferior good, or a Giffen good. While these are rather tricky concepts for students to understand, the reward for understanding them is considerable. For example, knowledge of these effects have allowed students to better understand how and why the labor supply curve may be backward bending, or why an increase in income taxes may cause some people to decrease their labor supply, while others may work more. Further, because of its subtle insights economists have debated many policies, among them, whether the food stamp voucher system or a cash subsidy is more effective in increasing the welfare of its recipients (Pindyck and Rubinfeld, 2013; Perloff, 2012; Salvatore 2008; Browning and Zupan, 2004; Nicholson, 2002; Mansfield and Yohe, 2003).

The production equivalent of the income and substitution effects, namely the output and substitution effects, using isoquant analysis is rarely if ever adopted in intermediate microeconomics textbooks (e.g., Salvatore 2008; Mansfield and Yohe, 2003; Varian, 2010; Pindyck and Rubinfeld, 2013; Perloff, 2012) to analyze the labor demand curve for an individual firm. In addition, neither general nor academic Internet sites (About.com Economics, 2012; Resources for Economists on the Internet, 2012) cover such analyses. It is the contention in this paper that integrating these effects into intermediate textbooks will provide a service to the discipline. These concepts may not only be useful to those preparing for graduate school; they may also facilitate a better learning in the intermediate macro and other advanced economic courses, such as industrial organization and public finance, at the undergraduate level. Further, it may stimulate

research, such as the impact of wage subsidies on labor demand that has hitherto been ignored. This paper develops a framework to integrate the output and substitution effects of price changes on labor demand into the intermediate microeconomics curriculum and textbooks.

The rest of this paper is organized as follows. In the next section, we provide a brief review of the literature, after which we analyze the substitution and output effects of a change in the price of labor on employment and output. We do this in different stages: we first assume that labor is a normal factor, after which we tackle the analysis assuming labor is inferior, and finally we take the logical next step with a comment on labor taking on Giffen characteristics. In the section thereafter, we briefly describe learning outcomes from such integration into the curriculum. The paper concludes with possible empirical applications in producer theory.

LITERATURE REVIEW

Whereas the most commonly used intermediate microeconomics textbooks do not analyze the substitution and output effects of a change in the price of an input (either capital (K) or labor (L)), several empirical studies have employed isoquant analysis for this purpose under different economic regimes. For example, Makin and Strong (2013) employ a Sato production function to explain the elasticity of substitution between labor**,** capital**,** and factor productivity for Australia during the 1980s economic reform era that substantially increased the flexibility of labor markets. Their study reveals that Australia's labor productivity and substitution elasticity rose significantly from the 1980s to the mid-1990s, during which time labor and product markets became highly flexible. This economic liberalization period also coincided with increased international trade, greater integration of financial markets into the global economy, and privatization. Chow (1990) shows that with rapid industrialization in Taiwan between the 1960s and 1980s, there has been a shift in labor demand from the primary sector to the secondary and tertiary sectors, even as wages increased. The author argues that during rapid industrialization, the economy witnessed increasing returns to labor, and hence a positive relationship between labor price and demand. Rapid export growth and capital accumulation further stimulated labor demand, thus reinforcing an upward sloping demand curve for labor during this era.

Other studies (Zind, 1979; Kako 1978) explore the effect of technical change on the rate of substitution between capital and labor. For example, Zind (1979) argues that while capital accumulation tends to depress the value of the elasticity of substitution between labor and capital, technical change will increase it and offset capital's negative impact on labor value. Kako (1978) investigates the process of rice production expansion in Japan between 1955-1970 using the Allen partial elasticities of substitution and other factors from the translog cost function, and isoquants analysis. The author decomposes a change in factor input demand into three analytical components, namely output changes, factor substitution along an existing isoquant, and technical change, which shifts the isoquant function. Kako concludes that the increase in labor demand, despite higher wages, during rapid economic growth in the Japanese economy, may be attributed primarily to technical change and declining capital prices.

Miller (1987) develops a model using new capital and old capital in replacement theory to explain that the demand curve for capital may be upward sloping. He argues that contrary to standard production theory that assumes there exists substitution between capital and labor, in reality, capital may be a substitute for other factors, and in this case, old capital. A relative fall in the price of capital could cause a replacement of old capital-intensive technology with less capital-intensive technology so that employers demand less capital at lower prices, creating a positively sloping capital demand. By implication, it may be argued that if the relative price of labor increases, but not substantially, as economies become more sophisticated, employing labor-enhancing rather than capital-intensive technology may yield a positively sloping labor demand curve.

One innovative study employs the output and substitution effect in production to explain labor discrimination. Galchus (1970) calculates the degree of labor substitutability between nonwhite and white workers in different occupations to analyze the degree of racial discrimination towards nonwhites. According to the study, employer discrimination manifests as the difference between the total and money costs imposed on an employer in hiring a nonwhite person, while worker and customer discrimination are integrated into the firm's isoquant. Based on the extent of labor substitutability, the author derives the demand curve for nonwhite labor, and concludes that in the absence of differences in worker traits by race, there is a perfect substitution of labor between whites and nonwhites, yielding a zero discrimination coefficient, and an integrated labor market.

Other studies (Gallagher and Hackleman, 1979; Killingsworth, 1985) investigate the impact of public policy on labor demand in terms of the substitution and output effects. Killingsworth (1985) considers the consequence of direct and indirect taxes and subsidies on the demand for private sector employment. Assuming labor is a normal factor, a positive subsidy and/or reduction in labor taxes will increase output due to the output effect. This would decrease product prices, which in turn would, after a series of adjustments, decrease output, and therefore, decrease employment, which defeats the purpose of the subsidy or decline in taxes. However, Killingsworth does not consider conditions in which the substitution effect may outweigh the output effect so the net result of a subsidy or tax reduction (usually administered during economic downturns or election cycles) may be an increase in output, albeit at falling product prices. It is likely that falling output prices may further stimulate the demand for labor as employers meet the increased demand for their products.

Studies on labor supply may have its parallels in labor demand theory. One such example involves a study by Nakamura and Murayama (2010) who demonstrate that under certain conditions the labor supply curve may resemble an inverted S-shape rather than the conventional backward bending curve that economists accept as true. In addition to the backward bend above the conventional upward slope reflecting a condition in which the income effect outweighs the substitution effect, a forward-falling segment below the conventional segment exists at extremely low wage levels where individuals operate at the subsistence level of consumption - the inverted s-shape. The authors reveal that such an inverted s-supply curve is observed in developing countries where the majority of the population operates at the subsistence level of consumption. However, it is also evident in developed countries in the presence of secondary workers such as spouses and dependents of primary breadwinners in the labor market.

The above literature reviewed underscores the importance of studying the output and substitution effects of a change in the price of labor (and capital) on production. For example, based on the results by Nakamura and Murayama (2010), it is not unreasonable to infer the existence of an S-shaped demand curve for labor, especially relevant to newly emerging economies, where the segments above and below the conventional segment of the labor demand curve reflect conditions in which the output effect outweighs the substitution effect. Similarly, in the politicized era of lower taxes and greater employment subsidies, studies of these effects on the intended outcome of higher demand for employment may be studied as Killingsworth did in 1985. Further, without too great a stretch of the imagination, the degree of labor substitutability between white (black) male and white (black) female (or between black and white) workers in executive positions may be analyzed to determine the existence of a glass ceiling coefficient. In this case, values equal to zero would reveal an integrated labor market with no glass ceiling, and values closer to one would reveal a strong segmented market. In the spirit of these possibilities for research, the following sections develop a model integrating the substitution and output effects of a change in the price of labor on the demand for labor.

SUBSTITUTION AND OUTPUT EFFECTS OF A CHANGE IN THE PRICE OF LABOR AS A NORMAL FACTOR

Underlying Assumptions and Properties of Isoquants

In developing a working model that describes how the output and substitution effects in production may be analyzed, we make ten simplifying assumptions: 1) The perfectly competitive firm is rational, profit-maximizing, and operates at efficiency; 2) Two homogenous inputs namely, capital (K) and labor (L), are utilized in producing good x, defined as a normal good; 3) Wages (P_L) is the only cost of labor, while the interest rate (P_K) is the only cost of capital; 4) P_L changes while P_K remains constant at $\overline{P}_K$, and total expenditure on K and L is held constant; 5) K is a normal factor of production whereas L can be normal, inferior, or Giffen; 6) Our analysis is situated in the long run so that all inputs are variable, allowing us to employ isoquant analysis; 7) Isoquants are negatively sloped indicating that for the same level of output, an increased usage of one of the factors necessitates a decrease in the use of the other factor; 8) Isoquants are convex to the origin, revealing a declining marginal rate of technical substitution of labor for capital ($MRTS_{LK}$) as more labor is hired; 9) The further isoquants are from the origin, the greater the output; and 10) Technology and the regulatory environment are held constant.

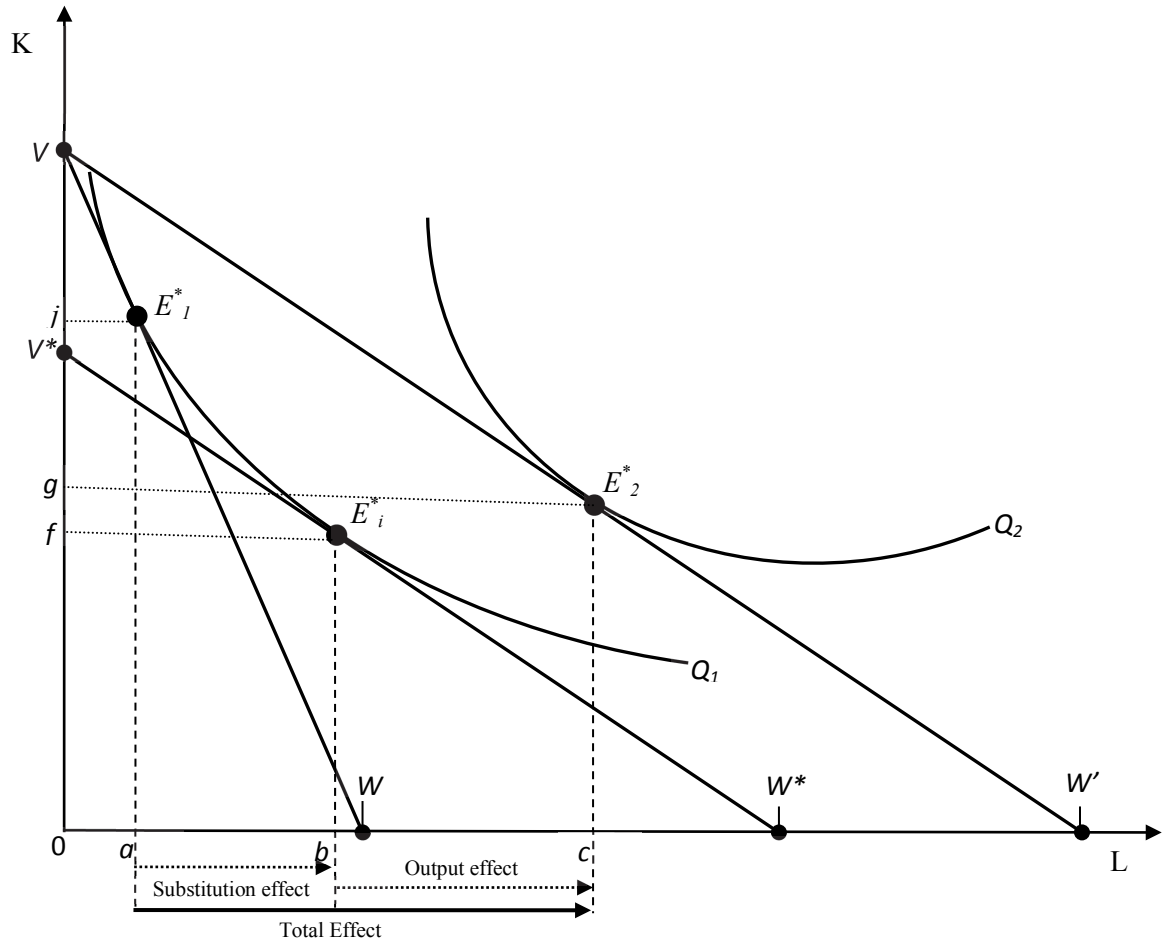
The labor demand curve conforms to the law of demand, which specifies an inverse relationship between the price of labor (P_L) and the quantity demanded of L *ceteris paribus*. The law of demand itself operates because of three factors, namely, the substitution effect, output effect, and diminishing $MRTS_{LK}$, and these in turn influence the price elasticity of labor demand. To understand the impact of a change in the price of labor on its quantity demanded, we separate the substitution effect from the output effect. This separation into the two effects presents an important analytical tool that is used to determine labor demand elasticity, as well as to examine the exception to the downward sloping labor demand curve for an individual firm, as in the case of a Giffen factor.

We know that when P_L falls, *ceteris paribus,* the firm hires more labor. In Figure 1, isocost curve VW represents the firm's expenditure on L and K, and isoquant Q_1 represents the firm's optimal output level given its expenditure. Initial equilibrium, where $MRTS_{LK} = P_L/\overline{P}_K$, exists at E^*_1 with *oa* of L and *oj* of K employed to produce Q_1 level of output. When P_L falls, holding $\overline{P}_K$ constant, the isocost curve pivots outwards from VW to VW', and a new equilibrium is now located at E^*_2. This change from E^*_1 to E^*_2 is the result of two separate forces at work: L has become cheaper relative to K, triggering the substitution effect; and the firm's expenditure power has gone up or real costs have gone down, enabling the firm to increase output without increasing expenditure on inputs. This is the output effect.

A Graphical Representation of the Substitution and Output Effects at Work

The Substitution Effect may be defined as the change in quantity demanded of labor because of a change in the $P_L/\overline{P}_K$ ratio, leaving output (or firm welfare) unchanged at the level before the price change. To identify the substitution effect we explore the impact of the new lower P_L on the firm's use of K and L without changing output from its original level. This amounts to returning the firm to the original production level (Q_1) at the new price ratio $P_{L2}/\overline{P}_K$. Graphically this involves a parallel shift of the VW' isocost curve to a fabricated isocost curve, V^*W^* as shown in Figure 1. The new imaginary equilibrium is located at E^*_i where V^*W^* is tangent to isoquant Q_1, and the $MRTS_{LK} = P_{L2}/\overline{P}_K$. The movement from E^*_1 to E^*_i, distance *ab,* is the substitution effect of a decrease in the relative price of labor, holding cost constant. Notice that the firm remains on the same level of production, Q_1, as before the decrease in P_L, but more L (distance *ab*) is employed by the substitution effect. At the same time, a negative cross elasticity of substitution between the price of L and K utilization leads to lower use of K (distance *jf*). Because the typical isoquant is convex to the origin, the substitution effect of a decrease in demand for L will always be opposite to the change in the P_L whether L is a normal or inferior input.

Figure 1: The substitution and output effect of a decrease in the price of labor as a normal factor



Starting from original equilibrium at E^*_1, the substitution effect is identified by drawing V^*W^* tangent to Q_1 at E^*_i and parallel to VW'. The movement along Q_1 from E^*_1 to E^*_i (horizontal distance ab) is the substitution effect. The movement from E^*_i on Q_1 to E^*_2 on Q_2 (horizontal distance bc) is the output effect. Since the output effect reinforces the substitution effect, the net effect, which is the movement from E^*_1 on Q_1 to E^*_2 on Q_2, is larger than the substitution effect, and conforms to the law of demand.

Having identified the substitution effect, we now turn to the output effect, which is defined as the change in the demand for L arising from an increase in the firm's expenditure power after a decrease in P_L. Graphically this signifies a rightward parallel shift of the fabricated isocost curve from V^*W^* back to the new isocost curve, VW' in Figure 1, leaving the new price ratio unchanged at $P_{L2}/\overline{P}_K$. This shift in the isocost curve reveals the increase in available funds to buy more L and K. Final equilibrium is at E^*_2 where the isocost curve VW" is tangent to the isoquant Q_2.The movement from E^*_i to E^*_2, distance *bc,* is the output effect of a decrease in the relative price of labor, *ceteris paribus*. Because L and K are normal factors, the firm's additional expenditure power spurs it to hire more labor as shown by distance *bc, and* more K as shown by distance *fg* in Figure 1.

The total effect of a reduction in P_L is the movement from E^*_1 to E^*_2, or distance *ac* in Figure 1, where the substitution (*ab*) and output (*bc*) effects reinforce each other. In this case, the substitution effect is smaller than the output effect, but in reality, the magnitude and direction of each effect depends upon the degree of substitutability between L and K, and the greater it is (the gentler the slope of the isoquant), the greater the substitution effect. Without complication, one can easily analyze the output and substitution effects of an increase in the relative price of L on output (Q) and employment of L and K. While in the real world,

we can only observe the total effect, analytically understanding the different effects allow for more informed decision-making at both the private and public policy levels.

If fixed proportions in production exist because perfect complementarity between K and L forces each to be used in fixed proportion to the other, the isoquants in Figure 1 will be right-angled at equilibrium E^*_1 and E^*_2, and there will be no substitution effect. Any decrease in the relative price of labor will result in only the output effect due to the firm's increased expenditure power.

Whereas the substitution effect will always be opposite to the change in P_L, the same cannot be said of the output effect. When labor is a normal factor, the output effect reinforces the substitution effect, but when labor is considered an inferior factor, the output effect opposes the substitution effect and negates the law of demand. Examples of production functions where labor is inferior is evident in high tech industries, large-scale commercial farming, and in industries, mostly in poorer economies, that are forced to be labor-intensive due to foreign exchange restrictions on imported capital. Therefore, we turn next to an analysis of the output and substitution effects of labor as an inferior factor.

OUTPUT AND SUBSTITUTION EFFECTS OF A CHANGE IN THE PRICE OF LABOR AS AN INFERIOR FACTOR.

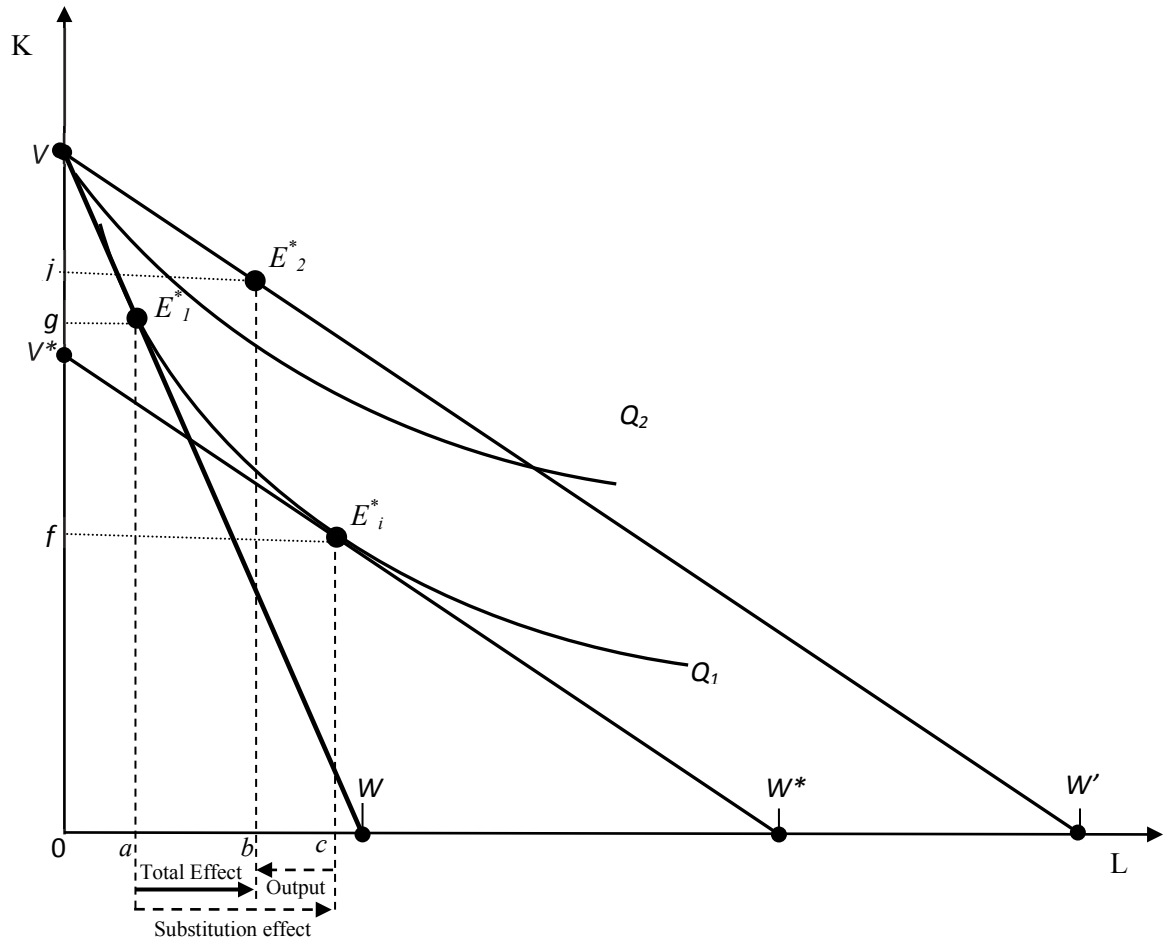
When L is a normal factor, the output and substitution effects reinforce each other, leading to a greater increase in labor demanded when P_L decreases, and vice versa. In the case of an inferior factor, however, the output effect negates the substitution effect. Nevertheless, in most production functions, the magnitude of the substitution effect is greater than that of the output effect, so the net effect of a decrease in P_L still yields an increase in labor demand, which is in harmony with the law of demand. While the L demand curve's negative slope is retained, it is steeper than under conditions of normality.

Figure 2 demonstrates the output and substitution effects of a decrease in P_L when labor is an inferior factor. Initial equilibrium exists at E^*_1. When P_L falls, holding P_K constant, the isocost curve pivots outwards from VW to VW', and the new equilibrium moves to E^*_2 and the demand for L increases by *ab*. Notice that this increase in labor employed attributed to a lower P_L is less than in Figure 1when labor is a normal factor.

As we did when labor was defined as a normal factor, we identify the substitution effect by analyzing the impact of the lower P_L on the firm's use of K and L without changing output from its original level at Q_1. This amounts to returning the firm to the original production level (Q_1) at the new price ratio $P_{L2}/\overline{P}_K$. In Figure 2 this manifests as a parallel shift of the VW' isocost curve to a fabricated isocost curve, V^*W^*. The new imaginary equilibrium is located at E^*_i where the fabricated isocost curve is tangent to the original isoquant Q_1, and $MRTS_{LK} = P_{L2}/\overline{P}_K$. The movement from E^*_1 to E^*_i, or distance *ac*, is the substitution effect where more L (distance *ac*) and less K (distance *gf*) are employed. Here, even though labor is an inferior factor, the substitution effect of a decrease in P_L nevertheless prompts an increase in L demanded from *oa* to *oc*.

Having isolated the substitution effect, we now turn to the output effect (movement from Q_1 to Q_2 in Figure 2) due to the firm's increased expenditure power. To demonstrate, we leave the relative price of labor unchanged at the new price ratio, $P_{L2}/\overline{P}_K$, leading to a parallel rightward shift of the isocost curve from V*W* to VW' in Figure 2. This shift signals an increase in funds available to employ more L and K without actually increasing its total expenditure on these factors. The new final equilibrium occurs at E^*_2 where isocost curve VW' is tangent to isoquant Q_2. The leftward movement from E^*_i to E^*_2, vector *cb*, is the output effect of a decrease in the relative price of labor, *ceteris paribus*. Because L is considered an inferior resource, the increased expenditure power from a lower P_L leads to lower employment of L (distance *cb*), and greater K utilization (distance *jf*). The obverse holds true for an increase in the P_L.

Figure 2: The substitution and output effect of a decrease in the price of labor as an inferior input



Starting from original equilibrium at E^*_1, the substitution effect is identified by drawing V^*W^* tangent to Q_1 at E^*_i and parallel to VW'. The movement along Q_1 from E^*_1 to E^*_i (horizontal distance ac) is the substitution effect. The movement from E^*_i on Q_1 to E^*_2 on Q_2 (horizontal distance cb) is the negative output effect of an inferior factor, L. Since the output effect works in opposition to the substitution effect, the net effect is the movement from E^*_1 on Q_1 to E^*_2 on Q_2, which is smaller than the substitution effect, but still conforms to the law of demand.

The combined output and substitution effect of the reduction in P_L, is the movement from E^*_1 to E^*_2, or distance *ab,* in Figure 2 when labor is defined as an inferior factor of production. Notice that even though the substitution and the output effects work in opposite directions, the former outweighs the latter. The net effect, therefore, of a decrease in P_L is an increase in the quantity demanded of labor according to the law of demand, but this increase is at a smaller rate than if L were a normal factor. When L is inferior, the downward sloping demand curve is steeper, and the price elasticity of demand for labor is lower than if labor is a normal factor. At the same time, the cross elasticity of substitution between the price of labor and capital demand is positive, as can be observed by the increased use of capital after the price change.

In the event the substitution effect of a decrease (or increase) in P_L of an inferior factor is overwhelmed by the opposing output effect, the L demand curve yields a positive slope with a direct relationship between P_L and the demand for labor, negating the law of demand. Under such circumstances, labor is defined as a Giffen factor. While a Giffen factor is a theoretical reality, it is more likely that the L demand curve will be positively sloping only at very low price levels. This situation prevails mostly in very poor developing countries, where a combination of no government regulations on wage and employment and limited foreign exchange for capital imports may create such an outcome.

LEARNING OUTCOMES

After eight years of teaching intermediate microeconomics, in 2000 I decided to integrate an analysis of the output and substitution effects of production into the course. There were two compelling reasons for this decision: First, I had been pondering for a while over the importance of this exercise in student thinking about the application of isoquants to production theory. After all, while numerous studies (among them, Autor and Duggan, 2007; Dalamagas, 2005; Ragan, 1994; Renaud and Siegers, 1984; Hanoch and Fraenkel, 1979; Hamermesh, 1977) have employed the income and substitution effects in consumption to empirically analyze labor supply and its implications for policy, only a few studies (Killingsworth, 1985; Gallagher and Hackleman, 1979; Galchus, 1970) have employed isoquant analysis to investigate the labor demand curve and its associated policy implications. Second, and more practically, students' low test grades on the income and substitution effects in consumption led me to wonder if analyzing the concept from a different angle, namely from the production perspective, would reinforce their understanding of both consumption and production theory. As an experiment in 2000, after completing consumer theory and testing students, I transitioned to producer theory. After analyzing isoquant analysis, I assigned students a team project where they were required to apply the income and substitution effects learned in consumer theory to production theory. What I found was that not only did the students come up with a parallel analysis, but they also performed much better in their exam on these topics, increasing their grade average by 5% that semester. Since then, grades have been higher on average than before, by between 5% and 10%. What has been more surprising, however, is that students have developed creative ideas in applying consumer and producer theories over the years. For example, one team in 2003 considered the possibility of a forward bending labor demand curve, parallel to the backward bending labor supply curve. Another team in 2006 applied the output and substitution effect to developing countries' decisions to employ different combination of L and K in the production process, depending on their level of integration into the market economy. One team in 2010 applied these effects to healthcare, erroneously arguing that an increase in nurses' pay increased the demand for nurses. In reality, it is true that nurses' pay have increased at the same time that the demand for them has increased in recent years, but these increases have been attributed to various other factors, among them, the greater utilization of nursing staff in medical facilities, while reducing the use of doctors. This mistake provided the perfect opportunity to remind students of the *ceteris paribus* assumption that students so often forget about. Overall, however, it seems as if a better understanding of the core material engenders creative applications of the subject matter. In addition, teaching these concepts in class has become an exciting adventure on my part as it has for my students, hence the need to share this model with other intermediate microeconomics professors.

CONCLUSION

This study has extended the analysis of the income and substitution effects in consumer theory to the output and substitution effects in producer theory, the analysis of which has been ignored for the most part in intermediate textbooks and in the classroom. This oversight may have led to the sparse empirical applications of the substitution and output effects on the demand for inputs, as indicated by Makin and Strong (2013), Chow (1990), Miller (1987), Killingsworth (1985), Gallagher and Hackleman (1979), Zind (1979), Kako (1978), and Melvin (1971). However, important insights into the factors influencing the production process may be derived from such studies, among them, the power of old capital versus new technology (Miller, 1987), and the role of urbanization and rapid economic growth (Makin and Strong, 2013; Chow, 1990; Kako, 1978), in the production process.

That no research exists on the output and substitution effects of a change in the price of labor when labor is an inferior (including Giffen) factor, may be because most theoretical research in this domain took place until the 1970s when economists focused mostly on developed countries. Since then, with the integration of poorer developing countries into the market economy, and the exponential growth of high-

tech capital-intensive industries amidst foreign exchange scarcity, the reality of labor as an inferior factor has become very real. An important question for consideration here, as students have asked, is "Could the labor demand curve for an individual firm be forward-bending at very low labor prices (in very poor countries and in developed countries with a large secondary labor market)?" Or, parallel to the existence of an inverse S-shaped labor supply curve, could the labor demand curve be S-shaped? The implication of such a curve has enormous implications for employment and public policy in an ever-changing global economy, and now that this globalized world has spawned considerably more economic and financial data, especially on developing economies, such hypotheses are more conducive to empirical investigation. It is therefore imperative for economists to integrate such studies in the intermediate microeconomics curriculum. Such analyses may also feature in labor and development economics, public finance, and even financial economics courses.

BIBLIOGRAPHY

About.com Economics. http://economics.about.com/. Last accessed, May 5, 2012.

Autor, D. H., and Duggan, M.G. 2007. Distinguishing Income from Substitution Effects in Disability Insurance. *American Economic Review* 97, no. 2: 119-124.

Browning, E.K. and Zupan, M.A. 2004. *Microeoconomic: Theory and Applications, 8th ed*. (New York: Wiley).

Chow, P. Y. 1990. Output Effect, Technology Change, and Labor Absorption in Taiwan, 1952-1986. *Economic Development & Cultural Change*, *39* (1), 77.

Dalamagas, B. 2005. Income and Substitution Effects of Fiscal Policy on Work Effort. *International Review of Applied Economics* 19, no. 2: 219-243.

Galchus K. 1970. *The Elasticity of Substitution of White for Nonwhite Labor* [e-book]. Available from: ERIC, Ipswich, MA.

Gallagher, D. G., & Hackleman, E. C. 1979. Isoquants, Collective Bargaining, and Public School Resource Allocation. *Journal of Economics & Business*, *31*(3), 160.

Hamermesh, D. S. 1977. A Note on Income and Substitution Effects in Search Unemployment. *Economic Journal* 87, no. 346: 312-314.

Hanoch, G., and Fraenkel, M. 1979. Income and Substitution Effects in the Two-Sector Open Economy. *American Economic Review* 69, no. 3: 455-458.

Kako, T. 1978. Decomposition Analysis of Derived Demand for Factor Inputs: The Case of Rice Production in Japan. *American Journal Of Agricultural Economics*, *60*(4), 628.

Killingsworth, M. R. 1985. Substitution and Output Effects on Labor Demand: Theory and Policy Applications. *Journal of Human Resources*, *20* (1), 142-152.

Makin, A. J., & Strong, S. 2013. New Measures of Factor Productivity in Australia: a Sato Approach. *Applied Economics*, *45*(17), 2413-2422.

Mansfield, Edward and Gary Yohe, 2003. *Intermediate Microeconomics, 11th ed*.(New York: W. W. Norton & Company)

Melvin, J. 1971. On the Derivation of the Production Possibility Curve. *Economica*, *38*(151), 287-294.

Miller, E. M. 1987. A Graphical Analysis of Replacement. *Southern Economic Journal*, *54*(1), 206.

Nakamura, T., and Murayama, Y. 2010. A Complete Characterization of the Inverted S-Shaped Labor Supply Curve. *Metroeconomica*, *61*(4), 665-675.

Nicholson, Walter. 2002. *Microeoconomic Theory: Basic Principles and Extensions , 8th ed*.(New York: Southwestern Thomson Learning).

Perloff, Jeffrey, M. 2012. *Microeoconomics , 6th ed*.(New Jersey: Pearson)

Pindyck, R.S., and Rubinfeld, D.L. 2013. *Microeoconomics , 8th ed*.(New Jersey: Prentice Hall).

Ragan, Christopher. 1994. Progressive Income Taxes and the Substitution Effect of RRSPs. *Canadian Journal of Economics* 27, no. 1: 43.

Renaud, P. S. A., and J. J. Siegers. 1984. Income and Substitution Effects in Family Labour Supply. *De Economist (0013-063X)* 132, no. 3: 350-366.

Resources for Economists on the Internet. http://rfe.org/. Last accessed, May 5, 2012.

Salvatore, Dominique. 2008. *Microeoconomic: Theory and Applications, 4th ed*.(New York: Oxford University Press).

Varian, Hal R. 2010. *Intermediate Microeconomics: A Modern Approach, 8th ed.* (New York: W. W. Norton & Company)

Zind, R. G. 1979. A Note on the Measurements of Technical Bias in the U.S. Economy. *Review of Economics & Statistics*, *61*(2), 301.

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