Chapter 3

DEMAND AND SUPPLY

QUESTIONS & ANSWERS

Q3.1 What key ingredients are necessary for the creation of economic demand?

Q3.1 ANSWER

Two basic conditions must be met before economic demand is created. First, there must be value associated with acquiring and using the good or service. For individuals, this value is measured in terms of utility, well-being, or satisfaction derived through consumption. For firms, this value is measured in terms of the profit created through resource employment. Second, there must be an ability to pay. Both individuals and firms must demonstrate an economic capability to acquire, or their wants will remain unfulfilled, and no economic demand will result.

Q3.2 Memory chip maker Micron Technology Inc. enjoys strong demand for its products from manufacturers of computers and intelligent electronics. Describe the difference between direct demand and derived demand.

Q3.2 ANSWER

Direct demand is consumption demand for goods and services. Direct demand is demand by consumers based on the satisfaction or utility derived from consumption. Derived demand is indirect in the sense that it represents demand by producers based on the usefulness of inputs in the production of goods and services for final consumption. Derived demand arises when it becomes profitable for a firm to use a given input in the production of some other valuable product.

Q3.3 The Ford Escape Hybrid is the first gas-electric hybrid SUV produced and sold in North America. How would Ford estimate the demand influence of growing environmental awareness by consumers?

Q3.3 ANSWER

Variables are included in a demand function because they are thought to affect the quantity of a product that will be purchased. Some variables such as income, education, age, family size, and so on, are included in an attempt to identify socio-
economic relations that influence demand. To the extent that environmental awareness is higher among the highly educated, or among those with high incomes, demand influences of environmental awareness could be captured by those variables. Otherwise, consumer interviews might identify characteristics of consumers with strong environmental concerns. Others factors, like price, price of competing goods, advertising expenditures, and so on, are included to account for closely linked economic forces as well as broader market conditions.

Q3.4 The Energy Department estimates that domestic demand for natural gas will grow by more than 40% between now and 2025. Distinguish between a demand function and a demand curve. What is the difference between a change in the quantity demanded and a shift in the demand curve?

Q3.4 ANSWER

A demand function is a statement of the relation between the demand for a product and all variables (factors) that affect demand. The demand curve, on the other hand, is an expression of the relation between price and the quantity demanded, holding constant the effect of all other demand influencing variables. Movement along a demand curve describes the relation between price changes and the quantity demanded. Shifts in a demand curve or changes in demand indicate the effect on demand of changes in one or more of the nonprice variables in the demand function.

Q3.5 What key ingredients are necessary for the creation of economic supply?

Q3.5 ANSWER

Two basic conditions must be satisfied before economic supply can be created. First, there must be a willingness among producers to supply output. It must be profitable for them to do so. Second, there must be an economic capability for doing so. Thus, firms must be both willing and able before economic supply can be created.

Q3.6 The United States is a big exporter of animal feeds, corn, meat, fruits, vegetables and other agricultural commodities. Explain how foreign trade affects the domestic supply of such products.

Q3.6 ANSWER

The supply function includes all of those factors with an important direct influence on the quantity supplied. As the price of a product rises, so too will supply as
Demand and Supply

producers seek to earn a profit by meeting consumer demands. When the price of a product falls, supply also falls as firms are no longer able to justify the added expense typically involved with generating higher levels of output. When firms can use productive resources to supply alternate products with greater profit potential, they will switch capacity to the alternate product and thereby reduce supply of the initial product. Conversely, an increase in prices for complementary products can increase the supply of each (e.g., wheat and straw). Supply will also tend to rise with advances in technology, falling input prices, and favorable weather conditions. Supply will fall with rising input prices and unfavorable weather conditions.

The fact that the United States is a big net exporter of agricultural commodities means that the domestic agricultural industry is much larger and much more productive than it would be with closed world markets.

Q3.7 Distinguish between a supply function and a supply curve. What is the difference between a change in the quantity supplied and a shift in the supply curve?

Q3.7 ANSWER

A supply function is a statement of the relation between the supply of a product and all variables (factors) that influence supply. On the other hand, the supply curve expresses the relation between the quantity supplied and price of the product itself, holding constant the effects of all other supply-related variables. Movements along a supply curve indicate the change in quantity supplied associated with a given change in product price. A shift in supply describes the change in the whole supply curve associated with a change in an important nonprice determinant of supply.

Q3.8 Dynamic rather than static demand and supply conditions are typically observed in real-world markets. Therefore, comparative statics analysis has only limited value. Discuss this statement.

Q3.8 ANSWER

The statement “all else equal” seldom holds in dynamic real-world markets. Nevertheless, comparative statics analysis provides a useful guide to managerial decision making by illustrating the likely consequences following various changes in demand and supply conditions. With comparative statics analysis, managers are better able to assess the relative costs and benefits associated with various decisions. Although comparative statics analysis removes none of the uncertainty associated with dynamic product markets, the method provides a very useful framework for managerial decision making.

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Chapter 3

Q3.9  Contrast the supply and demand conditions for new Ph.D. s in economics and accounting. Why do such large differences in starting salaries seem to persist over time?

Q3.9  ANSWER

Economics, like psychology, has long been regarded as an important component of a well-balanced liberal arts education. As such, the subject of economics is exposed to a large number of undergraduate students early in their academic career and is typically a popular major field of study. The importance of economics in everyday life and extensive coverage in the print and television media undoubtedly contribute to its popularity. On the other hand, accounting is widely regarded as an important element of a broad-based education in business. Like economics and psychology, courses in accounting are exposed to a broad range of undergraduates, and accounting is a popular business major. As a result, there is substantial demand for Ph.D.s in economics and accounting to teach at both colleges and universities.

The difference in supply and demand conditions for academic economists versus accountants is compelling and reflects a broad range of influences. First among these perhaps is the fact that the practical orientation of most undergraduate accounting programs translates into attractive job opportunities that make the accounting Ph.D. relatively unattractive. Talented accounting majors seek jobs with top accounting firms, pass the CPA exam, and go on to lucrative business careers. The opportunity cost of time spent in an accounting Ph.D. program is, for many, just too high. More theoretical economics undergraduate programs often lead to less specific job market skills and often translate into relatively lower starting salaries for economics majors. This makes for lower opportunity costs for economics (versus accounting) majors. Of course, the broad background offered by an economics major provides these students with the basis for effective on-the-job learning and quick advancement. Still, in the short run, the opportunity cost of graduate study is typically lower for economics students than for accounting students and helps explain the relatively large supply of economics Ph.D.s.

And finally, a lack of information contributes to demand/supply imbalance in these markets. Until recently, many talented (economics) undergraduates were simply unaware of current issues in accounting research and of the broad range of attractive academic opportunities in the accounting profession.

Q3.10  Suppose the personal income tax was replaced with a national sales tax. How would this affect aggregate supply, aggregate demand and interest rates?
Economists, like Milton Friedman, sometimes favor replacing the personal income tax with a national sales tax on the grounds that it is better to tax consumption (what is taken out of the economy) rather than income (what is put into the economy). Like a value-added tax or any tax on consumption, imposition of a national sales tax would have the effect of making current consumption relatively more expensive. As a result, some limiting influence on aggregate demand is to be expected. Any such decrease in consumption would have, by default, an increasing effect on savings and might lower interest rates. By itself, lower interest rates can lead to increased aggregate supply. In this instance, the supply-increasing affect of lower interest rates (an increase in supply push) might be lessened somewhat by the reduction in demand (a fall in demand pull).

Of course, tax law changes involve both efficiency and equity considerations. Unless properly designed, a national sales tax might tend to fall heavily on lower-income groups. For this reason, some economist might prefer income tax versus consumption-based tax financing of government programs.

SELF-TEST PROBLEMS & SOLUTIONS

ST3.1 Demand and Supply Curves. The following relations describe demand and supply conditions in the lumber/forest products industry

\[ Q_D = 80,000 - 20,000P \]  
\[ Q_S = -20,000 + 20,000P \]

where \( Q \) is quantity measured in thousands of board feet (one square foot of lumber, one inch thick) and \( P \) is price in dollars.

A. Set up a spreadsheet to illustrate the effect of price \( (P) \), on the quantity supplied \( (Q_S) \), quantity demanded \( (Q_D) \), and the resulting surplus \( (+) \) or shortage \( (-) \) as represented by the difference between the quantity supplied and the quantity demanded at various price levels. Calculate the value for each respective variable based on a range for \( P \) from $1.00 to $3.50 in increments of \( 0.10 \) (i.e., $1.00, $1.10, $1.20, . . . $3.50).

B. Using price \( (P) \) on the vertical or y-axis and quantity \( (Q) \) on the horizontal or x-axis, plot the demand and supply curves for the lumber/forest products industry over the range of prices indicated previously.
### ST3.1 SOLUTION

A. A table or spreadsheet that illustrates the effect of price (P), on the quantity supplied (Q<sub>s</sub>), quantity demanded (Q<sub>d</sub>), and the resulting surplus (+) or shortage (-) as represented by the difference between the quantity supplied and the quantity demanded at various price levels is as follows:

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity Demanded</th>
<th>Quantity Supplied</th>
<th>Surplus (+) or Shortage (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.00</td>
<td>60,000</td>
<td>0</td>
<td>-60,000</td>
</tr>
<tr>
<td>1.10</td>
<td>58,000</td>
<td>2,000</td>
<td>-56,000</td>
</tr>
<tr>
<td>1.20</td>
<td>56,000</td>
<td>4,000</td>
<td>-52,000</td>
</tr>
<tr>
<td>1.30</td>
<td>54,000</td>
<td>6,000</td>
<td>-48,000</td>
</tr>
<tr>
<td>1.40</td>
<td>52,000</td>
<td>8,000</td>
<td>-44,000</td>
</tr>
<tr>
<td>1.50</td>
<td>50,000</td>
<td>10,000</td>
<td>-40,000</td>
</tr>
<tr>
<td>1.60</td>
<td>48,000</td>
<td>12,000</td>
<td>-36,000</td>
</tr>
<tr>
<td>1.70</td>
<td>46,000</td>
<td>14,000</td>
<td>-32,000</td>
</tr>
<tr>
<td>1.80</td>
<td>44,000</td>
<td>16,000</td>
<td>-28,000</td>
</tr>
<tr>
<td>1.90</td>
<td>42,000</td>
<td>18,000</td>
<td>-24,000</td>
</tr>
<tr>
<td>2.00</td>
<td>40,000</td>
<td>20,000</td>
<td>-20,000</td>
</tr>
<tr>
<td>2.10</td>
<td>38,000</td>
<td>22,000</td>
<td>-16,000</td>
</tr>
<tr>
<td>2.20</td>
<td>36,000</td>
<td>24,000</td>
<td>-12,000</td>
</tr>
<tr>
<td>2.30</td>
<td>34,000</td>
<td>26,000</td>
<td>-8,000</td>
</tr>
<tr>
<td>2.40</td>
<td>32,000</td>
<td>28,000</td>
<td>-4,000</td>
</tr>
<tr>
<td>2.50</td>
<td>30,000</td>
<td>30,000</td>
<td>0</td>
</tr>
<tr>
<td>2.60</td>
<td>28,000</td>
<td>32,000</td>
<td>4,000</td>
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<tr>
<td>2.70</td>
<td>26,000</td>
<td>34,000</td>
<td>8,000</td>
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<td>2.80</td>
<td>24,000</td>
<td>36,000</td>
<td>12,000</td>
</tr>
<tr>
<td>2.90</td>
<td>22,000</td>
<td>38,000</td>
<td>16,000</td>
</tr>
<tr>
<td>3.00</td>
<td>20,000</td>
<td>40,000</td>
<td>20,000</td>
</tr>
</tbody>
</table>
Lumber and Forest Industry Supply and Demand Relationships

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity Demanded</th>
<th>Quantity Supplied</th>
<th>Surplus (+) or Shortage (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.10</td>
<td>18,000</td>
<td>42,000</td>
<td>24,000</td>
</tr>
<tr>
<td>3.20</td>
<td>16,000</td>
<td>44,000</td>
<td>28,000</td>
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<td>3.30</td>
<td>14,000</td>
<td>46,000</td>
<td>32,000</td>
</tr>
<tr>
<td>3.40</td>
<td>12,000</td>
<td>48,000</td>
<td>36,000</td>
</tr>
<tr>
<td>3.50</td>
<td>10,000</td>
<td>50,000</td>
<td>40,000</td>
</tr>
</tbody>
</table>

B. Using price (P) on the vertical Y axis and quantity (Q) on the horizontal X axis, a plot of the demand and supply curves for the lumber/forest products industry is as follows:

**ST3.2 Supply Curve Determination.** Information Technology, Inc., is a supplier of math coprocessors (computer chips) used to speed the processing of data for analysis on personal computers. Based on an analysis of monthly cost and output data, the company has estimated the following relation between the marginal cost of production and monthly output:
MC = $100 + 0.004Q.

A. Calculate the marginal cost of production at 2,500, 5,000, and 7,500 units of output.

B. Express output as a function of marginal cost. Calculate the level of output when MC = $100, $125, and $150.

C. Calculate the profit-maximizing level of output if wholesale prices are stable in the industry at $150 per chip and, therefore, P = MR = $150.

D. Derive the company’s supply curve for chips assuming P = MR. Express price as a function of quantity and quantity as a function of price.

ST3.2 SOLUTION

A. Marginal production costs at each level of output are:

\[
\begin{align*}
Q = 2,500: & \quad MC = $100 + 0.004(2,500) = $110 \\
Q = 5,000: & \quad MC = $100 + 0.004(5,000) = $120 \\
Q = 7,500: & \quad MC = $100 + 0.004(7,500) = $130
\end{align*}
\]

B. When output is expressed as a function of marginal cost:

\[
\begin{align*}
MC &= $100 + 0.004Q \\
0.004Q &= -100 + MC \\
Q &= -25,000 + 250MC
\end{align*}
\]

The level of output at each respective level of marginal cost is:

\[
\begin{align*}
MC = $100: & \quad Q = -25,000 + 250($100) = 0 \\
MC = $125: & \quad Q = -25,000 + 250($125) = 6,250 \\
MC = $150: & \quad Q = -25,000 + 250($150) = 12,500
\end{align*}
\]

C. Note from part B that MC = $150 when Q = 12,500. Therefore, when MR = $150, Q = 12,500 will be the profit-maximizing level of output. More formally:
Demand and Supply

MR = MC

$150 = $100 + $0.004Q

0.004Q = 50

Q = 12,500

D. Because prices are stable in the industry, P = MR, this means that the company will supply chips at the level of output where

MR = MC

and, therefore, that

P = $100 + $0.004Q

This is the supply curve for math chips, where price is expressed as a function of quantity. When quantity is expressed as a function of price:

P = $100 + $0.004Q

0.004Q = -100 + P

Q = -25,000 + 250P

PROBLEMS & SOLUTIONS

P3.1 Demand and Supply Curves. The following relations describe monthly demand and supply conditions in the metropolitan area for recyclable aluminum

\[ Q_D = 317,500 - 10,000P \quad \text{(Demand)} \]
\[ Q_S = 2,500 + 7,500P, \quad \text{(Supply)} \]

where Q is quantity measured in pounds of scrap aluminum and P is price in cents. Complete the following table:
P3.1 SOLUTION

<table>
<thead>
<tr>
<th>Price (1)</th>
<th>Quantity Supplied (2)</th>
<th>Quantity Demanded (3)</th>
<th>Surplus (+) or Shortage (-) (4) = (2) - (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>154</td>
<td>115,000</td>
<td>167,500</td>
<td>-52,500</td>
</tr>
<tr>
<td>16</td>
<td>122,500</td>
<td>157,500</td>
<td>-35,000</td>
</tr>
<tr>
<td>17</td>
<td>130,000</td>
<td>147,500</td>
<td>-17,500</td>
</tr>
<tr>
<td>18</td>
<td>137,500</td>
<td>137,500</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>145,000</td>
<td>127,500</td>
<td>17,500</td>
</tr>
<tr>
<td>20</td>
<td>152,500</td>
<td>117,500</td>
<td>35,000</td>
</tr>
</tbody>
</table>

P3.2 Demand and Supply Curves. The following relations describe monthly demand and supply relations for dry cleaning services in the metropolitan area:

\[ Q_D = 500,000 - 50,000P \]  

(Demand)

\[ Q_S = -100,000 + 100,000P \]  

(Supply)

where \( Q \) is quantity measured by the number of items dry cleaned per month and \( P \) is average price in dollars.

A. At what average price level would demand equal zero?

B. At what average price level would supply equal zero?
Demand and Supply

C. Calculate the equilibrium price/output combination.

P3.2 SOLUTION

A. From the demand relation, note that demand equals zero when:

\[ Q_D = 500,000 - 50,000P \]

\[ 0 = 500,000 - 50,000P \]

\[ 50,000P = 500,000 \]

\[ P = $10 \]

B. From the supply relation, note that supply equals zero when:

\[ Q_S = -100,000 + 100,000P \]

\[ 0 = -100,000 + 100,000P \]

\[ 100,000P = 100,000 \]

\[ P = $1 \]

C. The equilibrium price/output relation is found by setting \( Q_D = Q_S \) and solving for \( P \) and \( Q \):

\[ Q_D = Q_S \]

\[ 500,000 - 50,000P = -100,000 + 100,000P \]

\[ 150,000P = 600,000 \]

\[ P = $4 \]

Then,

\[ Q_D = ? \quad Q_S \]

\[ 500,000 - 50,000($4) = ? \quad -100,000 + 100,000($4) \]

\[ 300,000 = 300,000 \]
Chapter 3

P3.3 Demand Analysis. The demand for housing is often described as being highly cyclical and very sensitive to housing prices and interest rates. Given these characteristics, describe the effect of each of the following in terms of whether it would increase or decrease the quantity demanded or the demand for housing. Moreover, when price is expressed as a function of quantity, indicate whether the effect of each of the following is an upward or downward movement along a given demand curve or involves an outward or inward shift in the relevant demand curve for housing. Explain your answers.

A. An increase in housing prices

B. A fall in interest rates

C. A rise in interest rates

D. A severe economic recession

E. A robust economic expansion

P3.3 SOLUTION

A. An increase in housing prices will decrease the quantity demanded and involve an upward movement along the housing demand curve.

B. A fall in interest rates will increase the demand for housing and cause an outward shift of the housing demand curve.

C. A rise in interest rates will decrease the demand for housing and cause an inward shift of the housing demand curve.

D. A severe economic recession (fall in income) will decrease the demand for housing and result in an inward shift of the housing demand curve.

E. A robust economic expansion (rise in income) will increase the demand for housing and result in an outward shift of the housing demand curve.

P3.4 Demand and Supply Curves. Demand and supply conditions in the market for unskilled labor are important concerns to business and government decision makers. Consider the case of a federally mandated minimum wage set above the equilibrium,
or market clearing, wage level. Some of the following factors have the potential to influence the demand or quantity demanded of unskilled labor. Influences on the supply or quantity supplied may also result. Holding all else equal, describe these influences as increasing or decreasing, and indicate the direction of the resulting movement along or shift in the relevant curve(s).

A. An increase in the quality of secondary education.

B. A rise in welfare benefits.

C. An increase in the popularity of self-service gas stations, car washes, and so on.

D. A fall in interest rates.

E. An increase in the minimum wage.

P3.4 SOLUTION

A. An increase in the quality of secondary education has the effect of increasing worker productivity and will cause an increase or rightward shift in the demand for unskilled labor. To the extent that the benefits of an increase in the quality of education are recognized by students, more will stay in school and a secondary effect of a decrease or leftward shift in the supply of unskilled labor will also be observed. This shift will be reinforced as workers graduate from the unskilled to the skilled segment of the labor force.

B. A rise in welfare benefits makes not working more attractive and will cause a decrease or leftward shift in the supply of unskilled labor.

C. Self-service gas stations, car washes, and so on, involve a substitution of the consumer's own labor for hired unskilled labor. As self-serve increases in popularity, a decrease, or leftward shift, in the demand for unskilled labor occurs.

D. Holding all else equal, a fall in interest rates will increase the attractiveness of capital relative to labor. Employers can be expected to substitute capital for the now relatively more expensive labor. A decrease or leftward shift in the demand for unskilled labor will result. Of course, this influence can be mitigated to the extent that lower interest rates spur capital investment and a subsequent increase in employment opportunities.

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E. An increase in the minimum wage will have the effect of decreasing the quantity demanded of unskilled labor, while at the same time increasing the quantity supplied. The first involves an upward movement along the demand curve, while the second involves an upward movement along the supply curve.

P3.5 Demand Function. The Creative Publishing Company (CPC) is a coupon book publisher with markets in several southeastern states. CPC coupon books are either sold directly to the public, sold through religious and other charitable organizations, or given away as promotional items. Operating experience during the past year suggests the following demand function for CPC’s coupon books:

\[ Q = 5,000 - 4,000P + 0.02\text{Pop} + 0.375I + 1.5A, \]

where \( Q \) is quantity, \( P \) is price ($), \( \text{Pop} \) is population, \( I \) is disposable income per household ($), and \( A \) is advertising expenditures ($).

A. Determine the demand faced by CPC in a typical market in which \( P = $10, \text{Pop} = 1,000,000 \) persons, \( I = $40,000 \), and \( A = $10,000 \).

\[
Q = 5,000 - 4,000(10) + 0.02(1,000,000) + 0.375(40,000) + 1.5(10,000) \\
= 15,000
\]

B. Calculate the level of demand if CPC increases annual advertising expenditures from $10,000 to $15,000.

\[
Q = 5,000 - 4,000(10) + 0.02(1,000,000) + 0.375(40,000) + 1.5(15,000) \\
= 20,000
\]

C. Calculate the demand curves faced by CPC in parts A and B.

P3.5 Solution

A. The demand faced by CPC in a typical market in which \( P = $10, \text{Pop} = 1,000,000 \) persons, \( I = $40,000 \), and \( A = $10,000 \) is:

\[
Q = 5,000 - 4,000P + 0.02\text{Pop} + 0.375I + 1.5A \\
= 5,000 - 4,000(10) + 0.02(1,000,000) + 0.375(40,000) + 1.5(10,000) \\
= 15,000
\]

B. If advertising rises from $10,000 to $15,000, CPC demand rises to:

\[
Q = 5,000 - 4,000P + 0.02\text{Pop} + 0.375I + 1.5A \\
= 5,000 - 4,000(10) + 0.02(1,000,000) + 0.375(40,000) + 1.5(15,000) \\
= 20,000
\]

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Demand and Supply

C. The effect of an increase in advertising from $10,000 to $15,000 is to shift the demand curve upward following a 7,500 unit increase in the intercept term. If advertising is $10,000, the CPC demand curve is:

\[ Q = 5,000 - 4,000P + 0.02(1,000,000) + 0.375(40,000) + 1.5(10,000) \]

\[ = 55,000 - 4,000P \]

Then, price as a function of quantity is:

\[ Q = 55,000 - 4,000P \]

\[ 4,000P = 55,000 - Q \]

\[ P = $13.75 - 0.00025Q \]

If advertising is $15,000, the CPC demand curve is

\[ Q = 5,000 - 4,000P + 0.02(1,000,000) + 0.375(40,000) + 1.5(15,000) \]

\[ = 62,500 - 4,000P \]

Then, price as a function of quantity is:

\[ Q = 62,500 - 4,000P \]

\[ 4,000P = 62,500 - Q \]

\[ P = $15.625 - 0.00025Q \]

P3.6 **Demand Curves.** The Eastern Shuttle, Inc., is a regional airline providing shuttle service between New York and Washington, D.C. An analysis of the monthly demand for service has revealed the following demand relation:

\[ Q = 26,000 - 500P - 250P_{OG} + 200I_B - 5,000S, \]

where \( Q \) is quantity measured by the number of passengers per month, \( P \) is price ($), \( P_{OG} \) is a regional price index for other consumer goods (1967 = 1.00), \( I_B \) is an index.

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of business activity, and \( S \), a binary or dummy variable, equals 1 in summer months and 0 otherwise.

A. Determine the demand curve facing the airline during the winter month of January if \( P_{OG} = 4 \) and \( I_B = 250 \).

B. Determine the demand curve facing the airline, quantity demanded, and total revenues during the summer month of July if \( P = $100 \) and all other price-related and business activity variables are as specified previously.

P3.6 SOLUTION

A. The demand curve facing Eastern during the winter month of January can be calculated by substituting the appropriate value for each respective variable into the firm’s demand function:

\[
Q = 26,000 - 500P - 250P_{OG} + 200I_B - 5,000S
\]

\[
= 26,000 - 500P - 250(4) + 200(250) - 5,000(0)
\]

\[
Q = 75,000 - 500P
\]

With price expressed as a function of quantity, the firm demand curve can be written:

\[
Q = 75,000 - 500P
\]

\[
500P = 75,000 - Q
\]

\[
P = $150 - $0.002Q
\]

B. During the summer month of July, the variable \( S = 1 \). Therefore, assuming that price-related values remain as before, the firm demand curve is:

\[
Q = 26,000 - 500P - 250(4) + 200(250) - 5,000(1)
\]

\[
= 70,000 - 500P
\]

The quantity demanded during July is:

\[
Q = 26,000 - 500(100) - 250(4) + 200(250) - 5,000(1)
\]
Demand and Supply

= 20,000 passengers

Total July revenue for the company is:

\[ TR = PHQ \]

= $100(20,000)
= $2,000,000

P3.7 Supply Function. A review of industry wide data for the jelly and jam manufacturing industry suggests the following industry supply function:

\[ Q = -59,000,000 + 500,000P - 125,000P_L - 500,000P_K + 2,000,000W, \]

where \( Q \) is cases supplied per year, \( P \) is the wholesale price per case (\$), \( P_L \) is the average price paid for unskilled labor (\$), \( P_K \) is the average price of capital (in percent), and \( W \) is weather measured by the average seasonal rainfall in growing areas (in inches).

A. Determine the industry supply curve for a recent year when \( P_L = 8 \), \( P_K = 10 \) percent, and \( W = 20 \) inches of rainfall. Show the industry supply curve with quantity expressed as a function of price and price expressed as a function of quantity.

B. Calculate the quantity supplied by the industry at prices of \( \$50 \), \( \$60 \), and \( \$70 \) per case.

C. Calculate the prices necessary to generate a supply of 4 million, 6 million, and 8 million cases.

P3.7 SOLUTION

A. With quantity expressed as a function of price, the industry supply curve is:

\[ Q = -59,000,000 + 500,000P - 125,000P_L - 500,000P_K + 2,000,000W \]

\[ = -59,000,000 + 500,000P - 125,000(8) - 500,000(10) + 2,000,000(20) \]

\[ = -25,000,000 + 500,000P \]
With price expressed as a function of quantity, the industry supply curve is:

\[ Q = -25,000,000 + 500,000P \]
\[ 500,000P = 25,000,000 + Q \]
\[ P = $50 + $0.000002Q \]

B. Industry supply at each respective price is:

- \( P = $50 \): \( Q = -25,000,000 + 500,000($50) = 0 \)
- \( P = $60 \): \( Q = -25,000,000 + 500,000($60) = 5,000,000 \)
- \( P = $70 \): \( Q = -25,000,000 + 500,000($70) = 10,000,000 \)

C. The price necessary to generate each level of supply is:

- \( Q = 4,000,000 \): \( P = $50 + $0.000002(4,000,000) = $58 \)
- \( Q = 6,000,000 \): \( P = $50 + $0.000002(6,000,000) = $62 \)
- \( Q = 8,000,000 \): \( P = $50 + $0.000002(8,000,000) = $66 \)

P3.8 **Supply Curve Determination.** Olympia Natural Resources, Inc., and Yakima Lumber, Ltd., supply cut logs (raw lumber) to lumber and paper mills located in the Cascades Mountain region in the state of Washington. Each company has a different marginal cost of production depending on its own cost of landowner access, labor and other cutting costs, the distance cut logs must be shipped, and so on. The marginal cost of producing one unit of output, measured as one thousand board feet of lumber (where one board foot is one square foot of lumber, one inch thick), is:

\[ MC_O = $350 + $0.00005Q_O \]  \hspace{1cm} (Olympia).
\[ MC_Y = $150 + $0.0002Q_Y \]  \hspace{1cm} (Yakima).

The wholesale market for cut logs is vigorously price competitive, and neither firm is able to charge a premium for its products. Thus, \( P = MR \) in this market.
Demand and Supply

A. Determine the supply curve for each firm. Express price as a function of quantity and quantity as a function of price. (Hint: Set \( P = MR = MC \) to find each firm’s supply curve.)

B. Calculate the quantity supplied by each firm at prices of $325, $350, and $375. What is the minimum price necessary for each individual firm to supply output?

C. Assuming these two firms make up the entire industry in the local area, determine the industry supply curve when \( P < $350 \).

D. Determine the industry supply curve when \( P > $350 \). To check your answer, calculate quantity at an industry price of $375 and compare your result with part B.

P3.8 SOLUTION

A. Each company will supply output to the point where \( MR = MC \). Because \( P = MR \) in this market, the supply curve for each firm can be written with price as a function of quantity as:

\[
\text{Olympia} \\
MR_O = MC_O \\
P = \$350 + 0.00005Q_O \\
\text{Yakima} \\
MR_Y = MC_Y \\
P = \$150 + 0.0002Q_Y
\]

When quantity is expressed as a function of price:

\[
\text{Olympia} \\
P = \$350 + 0.00005Q_O \\
0.00005Q_O = -350 + P \\
Q_O = -7,000,000 + 20,000P
\]

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- 65 -
Yakima

\[ P = 150 + 0.0002Q_Y \]

\[ 0.0002Q_Y = -150 + P \]

\[ Q_Y = -750,000 + 5,000P \]

B. The quantity supplied at each respective price is:

Olympia

\[ P = 325: Q_O = -7,000,000 + 20,000(325) = -500,000 \]  
(because \( Q < 0 \) is impossible)

\[ P = 350: Q_O = -7,000,000 + 20,000(350) = 0 \]

\[ P = 375: Q_O = -7,000,000 + 20,000(375) = 500,000 \]

Yakima

\[ P = 325: Q_Y = -750,000 + 5,000(325) = 875,000 \]

\[ P = 350: Q_Y = -750,000 + 5,000(350) = 1,000,000 \]

\[ P = 375: Q_Y = -750,000 + 5,000(375) = 1,125,000 \]

For Olympia, \( MC = 350 \) when \( Q_0 = 0 \). Because marginal cost rises with output, Olympia will never supply output unless a price in excess of \( 350 \) per unit can be obtained. Because negative output is not feasible, Olympia will simply fail to supply output when \( P < 350 \). Similarly, \( MC_Y = 150 \) when \( Q_Y = 0 \). Thus, Yakima will never supply output unless a price in excess of \$150 per unit can be obtained.

C. When \( P < 350 \), only Yakima can profitably supply output. The Yakima supply curve will be the industry curve when \( P < 350 \):

\[ P = 150 + 0.0002Q \]

or

\[ Q = -750,000 + 5,000P \]
Demand and Supply

D. When \( P > $350 \), both Olympia and Yakima can profitably supply output. To derive the industry supply curve in this circumstance, simply sum the quantities supplied by each firm:

\[
Q = Q_O + Q_Y
\]

\[
= -7,000,000 + 20,000P + (-750,000 + 5,000P)
\]

\[
= -7,750,000 + 25,000P
\]

To check, at \( P = $375 \):

\[
Q = -7,750,000 + 25,000($375)
\]

\[
= 1,625,000
\]

which is supported by the answer to part B, because \( Q_O + Q_Y = 500,000 + 1,125,000 = 1,625,000 \)

(Note: Some students mistakenly add prices rather than quantities in an attempt to derive the industry supply curve. To avoid this problem, it is important to emphasize that industry supply curves are found through adding up output (horizontal summation), not by adding up prices (vertical summation).)

P3.9 Supply Curve Determination. Cornell Pharmaceutical, Inc., and Penn Medical, Ltd., supply generic drugs to treat a wide variety of illnesses. A major product for each company is a generic equivalent of an antibiotic used to treat postoperative infections. Proprietary cost and output information for each company reveal the following relations between marginal cost and output:

\[
MC_C = $10 + $0.004Q_C \quad \text{(Cornell)}
\]

\[
MC_P = $8 + $0.008Q_P \quad \text{(Penn)}
\]

The wholesale market for generic drugs is vigorously price competitive, and neither firm is able to charge a premium for its products. Thus, \( P = MR \) in this market.

A. Determine the supply curve for each firm. Express price as a function of quantity and quantity as a function of price. (Hint: Set \( P = MR = MC \) to find each firm’s supply curve.)

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B. Calculate the quantity supplied by each firm at prices of $8, $10, and $12. What is the minimum price necessary for each individual firm to supply output?

C. Assuming these two firms make up the entire industry, determine the industry supply curve when \( P < $10 \).

D. Determine the industry supply curve when \( P > $10 \). To check your answer, calculate quantity at an industry price of $12 and compare your answer with part B.

**P3.9 SOLUTION**

**A.** Each company will supply output to the point where \( MR = MC \). Because \( P = MR \) in this market, the supply curve for each firm can be written with price as a function of quantity as:

\[
\begin{align*}
\text{Cornell} \\
MR_C &= MC_C \\
P &= $10 + $0.004Q_C \\
\text{Penn} \\
MR_P &= MC_P \\
P &= $8 + $0.008Q_P
\end{align*}
\]

When quantity is expressed as a function of price:

\[
\begin{align*}
\text{Cornell} \\
P &= $10 + $0.004Q_C \\
0.004Q_C &= -10 + P \\
Q_C &= -2,500 + 250P \\
\text{Penn} \\
P &= $8 + $0.008Q_P
\end{align*}
\]

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0.008Q_P = -8 + P

Q_P = -1,000 + 125P

B. The quantity supplied at each respective price is:

Cornell

P = $8: Q_C = -2,500 + 250($8) = -500 (because Q < 0 is impossible)

P = $10: Q_C = -2,500 + 250($10) = 0

P = $12: Q_C = -2,500 + 250($12) = 500

Penn

P = $8: Q_P = -1,000 + 125($8) = 0

P = $10: Q_P = -1,000 + 125($10) = 250

P = $12: Q_P = -1,000 + 125($12) = 500

For Cornell, MC = $10 when Q_C = 0. Because marginal cost rises with output, Cornell will never supply output unless a price in excess of $10 per unit can be obtained. Because negative output is not feasible, Cornell will simply fail to supply output when P < $10. Similarly, MC_P = $8 when Q_P = 0. Thus, Penn will never supply output unless a price in excess of $8 per unit can be obtained.

C. When P < $10, only Penn can profitably supply output. The Penn supply curve will be the industry curve when P < $10:

\[
P = 8 + 0.008Q
\]

or

\[
Q = -1,000 + 125P
\]

D. When P > $10, both Cornell and Penn can profitably supply output. To derive the industry supply curve in this circumstance, simply sum the quantities supplied by each firm:

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Chapter 3

\[ Q = Q_C + Q_P \]
\[ = -2,500 + 250P + (-1,000 + 125P) \]
\[ = -3,500 + 375P \]

To check, at \( P = $12 \):

\[ Q = -3,500 + 375(12) \]
\[ = 1,000 \]

which is supported by the answer to part B, because \( Q_C + Q_P = 500 + 500 = 1,000 \).

(Note: Some students mistakenly add prices rather than quantities in an attempt to derive the industry supply curve. To avoid this problem, emphasize that industry supply curves are found through adding up output (horizontal summation), not by adding up prices (vertical summation).)

P3.10 Market Equilibrium. Eye-de-ho Potatoes is a product of the Coeur d’Alene Growers’ Association. Producers in the area are able to switch back and forth between potato and wheat production depending on market conditions. Similarly, consumers tend to regard potatoes and wheat (bread and bakery products) as substitutes. As a result, the demand and supply of Eye-de-ho Potatoes are highly sensitive to changes in both potato and wheat prices.

Demand and supply functions for Eye-de-ho Potatoes are as follows:

\[ Q_D = -1,450 - 25P + 12.5P_W + 0.2Y, \quad \text{(Demand)} \]
\[ Q_S = -100 + 75P - 25P_W - 12.5P_L + 10R, \quad \text{(Supply)} \]

where \( P \) is the average wholesale price of Eye-de-ho Potatoes ($ per bushel), \( P_W \) is the average wholesale price of wheat ($ per bushel), \( Y \) is income (GNP in $ billions), \( P_L \) is the average price of unskilled labor ($ per hour), and \( R \) is the average annual rainfall (in inches). Both \( Q_D \) and \( Q_S \) are in millions of bushels of potatoes.

A. When quantity is expressed as a function of price, what are the Eye-de-ho Potatoes demand and supply curves if \( P_W = $4, Y = $7,500 billion, P_L = $8, \) and \( R = 20 \) inches?
**Demand and Supply**

**B.** Calculate the surplus or shortage of Eye-de-ho Potatoes when $P = $1.50, $2, and $2.50.

**C.** Calculate the market equilibrium price/output combination.

**P3.10 SOLUTION**

**A.** When quantity is expressed as a function of price, the demand curve for Eye-de-ho Potatoes is:

\[
Q_D = -1,450 - 25P + 12.5P_W + 0.2Y
\]

\[
= -1,450 - 25P + 12.5(4) + 0.2(7,500)
\]

\[
Q_D = 100 - 25P
\]

When quantity is expressed as a function of price, the supply curve for Eye-de-ho Potatoes is:

\[
Q_S = -100 + 75P - 25P_W - 12.5P_L + 10R
\]

\[
= -100 + 75P - 25(4) - 12.5(8) + 10(20)
\]

\[
Q_S = -100 + 75P
\]

**B.** The surplus or shortage can be calculated at each price level:

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity Supplied</th>
<th>Quantity Demanded</th>
<th>Surplus (+) or Shortage (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.50</td>
<td>$Q_S = -100 + 75($1.50) = 12.5</td>
<td>$Q_D = 100 - 25($1.50) = 62.5</td>
<td>-50</td>
</tr>
<tr>
<td>$2.00</td>
<td>$Q_S = -100 + 75($2) = 50</td>
<td>$Q_D = 100 - 25($2) = 50</td>
<td>0</td>
</tr>
<tr>
<td>$2.50</td>
<td>$Q_S = -100 + 75($2.50) = 87.5</td>
<td>$Q_D = 100 - 25($2.50) = 37.5</td>
<td>+50</td>
</tr>
</tbody>
</table>

**C.** The equilibrium price is found by setting the quantity demanded equal to the quantity supplied and solving for $P$:

\[
Q_D = Q_S
\]

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100 - 25P = -100 + 75P

100P = 200

P = $2

To solve for Q, set:

Demand: Q_D = 100 - 25($2) = 50 (million bushels)

Supply: Q_S = -100 + 75($2) = 50 (million bushels)

In equilibrium Q_D = Q_S = 50 (million bushels).

CASE STUDY FOR CHAPTER 3

Spreadsheet Analysis of Demand and Supply for Sunbest Orange Juice

Spreadsheet analysis is an appropriate means for studying the demand and supply effects of possible changes in various exogenous and endogenous variables. Endogenous variables include all important demand and supply-related factors that are within the control of the firm. Examples include product pricing, advertising, product design, and so on. Exogenous variables consist of all significant demand and supply-related influences that are beyond the control of the firm. Examples include competitor pricing, competitor advertising, weather, general economic conditions, and related factors.

In comparative statics analysis, the marginal influence on demand and supply of a change in any one factor can be isolated and studied in depth. The advantage of this approach is that causal relationships can be identified and responded to, if appropriate. The disadvantage of this marginal approach is that it becomes rather tedious to investigate the marginal effects of a wide range of demand and supply influences. It is here that spreadsheet analysis of demand and supply conditions becomes useful. Using spreadsheet analysis, it is possible to learn the demand and supply implications of an almost limitless range of operating scenarios. Rather than calculating the effects of only a few possibilities, it is feasible to consider even rather unlikely outcomes. A complete picture can be drawn of the firm's operating environment, and strategies for responding to a host of operating conditions can be drawn up.

To illustrate this process, consider the hypothetical case of Sunbest Orange Juice, a product of California's Orange County Growers' Association. Both demand and supply of the product are highly sensitive to changes in the weather. During hot summer months, demand for
**Demand and Supply**

Sunbest and other beverages grows rapidly. On the other hand, hot, dry weather has an adverse effect on supply by reducing the size of the orange crop.

Demand and supply functions for Sunbest are as follows:

\[
Q_D = 1,000,000 - 25,000,000P + 10,000,000P_S + 1,600Y + 50,000T \quad \text{(Demand)}
\]

\[
Q_S = 8,000,000P - 100,000P_L - 120,000PK - 150,000T \quad \text{(Supply)}
\]

where \( P \) is the average wholesale price of Sunbest ($ per case), \( P_S \) is the average wholesale price of canned soda ($ per case), \( Y \) is disposable income per household ($), \( T \) is the average daily high temperature (degrees), \( P_L \) is the average price of unskilled labor ($ per hour), and \( PK \) is the risk-adjusted cost of capital (in percent).

During the coming planning period, a wide variety of operating conditions are possible. To gauge the sensitivity of demand and supply to changes in these operating conditions, a number of scenarios that employ a range from optimistic to relatively pessimistic assumptions have been drawn up in Table 3.4.

Table 3.4 here

Demand and supply functions for Sunbest orange juice can be combined with data on the operating environment to construct estimates of demand, supply, and the amount of surplus or shortage under each operating scenario.

**A.** Set up a spreadsheet to illustrate the effects of changing economic assumptions on the demand for Sunbest orange juice. Use the demand function to calculate demand based on three different underlying assumptions concerning changes in the operating environment. First, assume that all demand factors change in unison from levels indicated in the Optimistic Scenario #1 to the levels indicated in Pessimistic Scenario #10. Second, fix all demand factors except the price of Sunbest at Scenario #6 levels, and then calculate the quantity demanded at each scenario price level. Finally, fix all demand factors except temperature at Scenario #6 levels, and then calculate demand at each scenario temperature level.

**B.** Set up a spreadsheet to illustrate the effects of changing economic assumptions on the supply of Sunbest orange juice. Use the supply function to calculate supply based on three different underlying assumptions concerning changes in the operating environment. First, assume that all supply factors change in unison from levels indicated in the Optimistic Scenario #1 to the levels indicated in Pessimistic Scenario #10. Second, fix all supply factors except the price of Sunbest at Scenario #6 levels, and then calculate the quantity supplied at each scenario price level. Finally, fix all supply factors except temperature at Scenario #6 levels, and then calculate supply at each scenario temperature level.
C. Set up a spreadsheet to illustrate the effect of changing economic assumptions on the surplus or shortage of Sunbest orange juice that results from each scenario detailed in part A and part B. Which operating scenario results in market equilibrium?

CASE STUDY SOLUTION

A. A spreadsheet that illustrates the effects of changing economic assumptions on the demand for Sunbest orange juice is as follows:

<table>
<thead>
<tr>
<th>Demand if All Factors Change (Q_d)</th>
<th>Quantity Demanded if Price Chg. Only (Q_d)</th>
<th>Demand if Temp. Chg. Only (Q_d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,062,500</td>
<td>0</td>
<td>25,062,500</td>
</tr>
<tr>
<td>14,450,000</td>
<td>5,000,000</td>
<td>25,050,000</td>
</tr>
<tr>
<td>16,837,500</td>
<td>10,000,000</td>
<td>25,037,500</td>
</tr>
<tr>
<td>19,225,000</td>
<td>15,000,000</td>
<td>25,025,000</td>
</tr>
<tr>
<td>21,612,500</td>
<td>20,000,000</td>
<td>25,012,500</td>
</tr>
<tr>
<td>25,000,000</td>
<td>25,000,000</td>
<td>25,000,000</td>
</tr>
<tr>
<td>26,387,500</td>
<td>30,000,000</td>
<td>24,987,500</td>
</tr>
<tr>
<td>28,775,000</td>
<td>35,000,000</td>
<td>24,975,000</td>
</tr>
<tr>
<td>31,162,500</td>
<td>40,000,000</td>
<td>24,962,500</td>
</tr>
<tr>
<td>33,550,000</td>
<td>45,000,000</td>
<td>24,950,000</td>
</tr>
</tbody>
</table>

B. A spreadsheet that depicts the consequence of changing economic assumptions on the supply of Sunbest orange juice is as follows:

<table>
<thead>
<tr>
<th>Supply if All Factors Change (Q_S)</th>
<th>Quantity Supplied if Price Chg. Only (Q_S)</th>
<th>Supply if Temp. Chg. Only (Q_S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33,237,500</td>
<td>33,000,000</td>
<td>24,812,500</td>
</tr>
<tr>
<td>31,590,000</td>
<td>31,400,000</td>
<td>24,850,000</td>
</tr>
<tr>
<td>29,942,500</td>
<td>29,800,000</td>
<td>24,887,500</td>
</tr>
<tr>
<td>28,295,000</td>
<td>28,200,000</td>
<td>24,925,000</td>
</tr>
<tr>
<td>26,647,500</td>
<td>26,600,000</td>
<td>24,962,500</td>
</tr>
<tr>
<td>25,000,000</td>
<td>25,000,000</td>
<td>25,000,000</td>
</tr>
</tbody>
</table>

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Demand and Supply

23,352,500  23,400,000  25,037,500
21,705,000  21,800,000  25,075,000
20,057,500  20,200,000  25,112,500
18,410,000  18,600,000  25,150,000

C. A spreadsheet illustration of the effect of changing economic assumptions on the surplus and shortage of *Sunbest* is:

<table>
<thead>
<tr>
<th>Surplus or Shortage</th>
<th>Surplus or Shortage</th>
<th>Surplus or Shortage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Factors Change</td>
<td>Price Chg. Only</td>
<td>Temp. Chg. Only</td>
</tr>
<tr>
<td>21,175,000</td>
<td>33,000,000</td>
<td>-250,000</td>
</tr>
<tr>
<td>17,140,000</td>
<td>26,400,000</td>
<td>-200,000</td>
</tr>
<tr>
<td>13,105,000</td>
<td>19,800,000</td>
<td>-150,000</td>
</tr>
<tr>
<td>9,070,000</td>
<td>13,200,000</td>
<td>-100,000</td>
</tr>
<tr>
<td>5,035,000</td>
<td>6,600,000</td>
<td>-50,000</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-3,035,000</td>
<td>-6,600,000</td>
<td>50,000</td>
</tr>
<tr>
<td>-7,070,000</td>
<td>-13,200,000</td>
<td>100,000</td>
</tr>
<tr>
<td>-11,105,000</td>
<td>-19,800,000</td>
<td>150,000</td>
</tr>
<tr>
<td>-15,140,000</td>
<td>-26,400,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

As is obvious from this spreadsheet, market equilibrium occurs under operating Scenario #6.