Chapter 5
Demand and Supply in Higher Education

Abstract In this chapter, we explain how demand and supply can be applied to higher education markets. We begin by providing some background on the economic concepts of markets, demand, and supply, and review historical data on college enrollments and key determinants of demand. We then build on the college choice model from Chap. 3 to identify the demand for higher education. In this section, we distinguish between individual and market demand, and then turn to the supply side of higher education markets. In the next section, we show how supply and demand are combined to find the market clearing price for higher education services, and the corresponding enrollment level. Following this section, we tackle the notion of elasticity and the various ways in which economists apply elasticity to higher education. In the Extensions to the model section, we briefly look at alternative measures of demand and how economists can use quasi-experimental methods to better measure price sensitivity of demand. Finally, the Policy Focus section discusses state broad-based financial aid programs and the growth of the for-profit industry within higher education.

Introduction

Nearly every year students face an increase in college tuition and fees over the previous year, and yet enrollments at America's colleges and universities continue to rise. Such counterintuitive relationships and even apparent 'mysteries' are all too common in the study of contemporary higher education and they sometimes seem almost impossible to explain. But there are many key economic concepts, theories and models that are particularly effective in providing insight and understanding into these complex patterns as well as their causes and effects. Some of the most productive and useful of these economic concepts and models include those associated with the theories of demand, supply and the marketplace, all of which can be applied in an analysis of higher education markets.

When it comes to higher education, economists are primarily concerned with the study of how scarce resources can be efficiently allocated and how the benefits and costs of college can be equitably distributed among students, schools and the rest of

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society. In the United States and other nations, these processes primarily take place in higher education markets. Economists use the concept of the marketplace or the market to represent those places, processes, arrangements, interactions, institutions and other contexts in which buyers (consumers) and sellers (producers) exchange valuable goods and services. In the marketplace setting, buyers and sellers work together to determine the prices and quantities of goods and services that are exchanged. In higher education markets, the valuable goods and services exchanged are bundles of instructional and related educational services, the buyers are students and their families, and the sellers are colleges and universities. Students and their families are free to make decisions regarding whether to go to college, where to go to college, and how much they would be willing to pay for specific institutions. Similarly, colleges and universities (or their governing bodies) in higher education markets make decisions regarding who to admit, how many students to admit, and what prices to charge. The *market price* of educational services is represented by the equilibrium or market-clearing tuition and fees per academic year and the *market quantity* of educational services is represented by enrollment or the quantity of students enrolled at the market-clearing price. It is in the market context that students and their families give up a portion of their time and money in order to acquire the benefits that they need and want from colleges.

In the marketplace setting, the interactions of buyers and sellers determine the prices and quantities of goods and services that are exchanged. In this context, demand theory explains buyer behavior and supply theory explains seller behavior. Demand theory identifies how various factors influence the choices made by buyers, and supply theory focuses on another set of factors that influence seller behavior. In combination, demand theory and supply theory constitute an economic model of the marketplace, based on the competitive theory of markets, that can explain how various demand-side and supply-side factors help determine the market prices and quantities of the goods and services exchanged.[1] Demand theory, supply theory and the market model can also help explain how changes in factors outside the immediate marketplace, such as changes in the general economy or population demographics, or changes in policies designed by federal, state and local governments, as well as institutions, can impact the behavior of buyers and/or sellers and the prices and quantities of goods and services exchanged.

[1] Competitive market assumptions represent an approximation of behavior in higher education markets, due to some price-setting and supply-side constraints the complicating effects of which are beyond the scope of this chapter and are not thoroughly addressed in this chapter's analyses using the competitive marketplace model. But even though few markets in real life approach the strict conditions required for perfect competition, markets exhibit degrees of competition and therefore, the competitive market model can help explain and predict market behavior and outcomes (e.g., see Belfield, 2000, p. 146; Steinemann, Apgar, & Brown, 2004, p. 52). Or, as Rothschild and White (1995) summarize the case regarding its applicability to the market for higher education: "we have argued that a competitive framework for analysis appears reasonable but that the nonprofit status of universities and the major role of non-tuition funds providers introduce special features into any competitive structure" (pp. 34–35).

In this chapter, we explain how demand and supply can be applied to higher education markets. We begin by providing some background on the economic concepts of markets, demand, and supply, and review historical data on college enrollments and key determinants of demand. We then build on the college choice model from Chap. 3 to identify the demand for higher education. In this section, we distinguish between individual and market demand, and then turn to the supply side of higher education markets. In the next section, we show how supply and demand are combined to find the market clearing price for higher education services, and the corresponding enrollment level. Following this section, we tackle the notion of elasticity and the various ways in which economists apply elasticity to higher education. In the Extensions to the model section, we briefly look at alternative measures of demand and how economists can use quasi-experimental methods to better measure price sensitivity of demand. Finally, the Policy Focus section discusses state broad-based financial aid programs and the growth of the for-profit industry within higher education.

Background

A *market* is where buyers and sellers of goods and services come together to engage in trade. The notion of markets dates back thousands of years as places where humans first began to trade goods and services with each other. Economists describe markets as a means for making decisions about what a society should produce, how goods and services will be distributed, and how much buyers will be charged for goods and services. As technology improved and humans became more mobile, markets became less place-bound. Today, there are numerous examples of markets where transactions occur without buyers and sellers ever meeting in person.

There is a long and rich history behind the development of markets, demand, and supply.[2] Discussions of demand and supply can be traced back to the eighteenth century through the work of Sir James Steuart (1767) and Adam Smith (1776), followed by Ricardo (1817–21). In *Researches Into the Mathematical Principles of the Theory of Wealth* (1838) by Antoine Cournot, these ideas were formalized into what we now know as demand and supply curves.[3] It was not until the publication of Alfred Marshall's classic textbook *Principles of Economics* (1890), however, that supply and demand curves became a staple of economic analysis. We explore the concept of markets in higher education more fully in Chap. 8.

[2] An excellent survey of the development of demand and supply curves can be found in Humphrey (1992).

[3] Other economists of note in this early period include Rau (1841), who explained the stability of equilibrium in markets, and Mangoldt (1863), who offered a simple algebraic model of supply, demand, and equilibrium.

As documented by literature reviews on the subject, there have been numerous empirical studies on the demand for postsecondary education.[4] Although the early literature on demand for higher education focused on the United States, many subsequent studies have been conducted around the globe.[5] In general, these studies have focused primarily on two issues: forecasting demand for higher education, and measuring the sensitivity of demand to changes in price. The general conclusion from the literature is that the demand for postsecondary education is relatively unaffected by price changes. Studies of the demand for postsecondary education seek to explain trends in college enrollments, forecast future demand, and understand how students make decisions about whether to go to college, and if so, where to enroll.

The levels of postsecondary enrollment can provide us with some information about how the demand for higher education has changed over time. Table 5.1 provides data on postsecondary enrollments in the United States in selected years from 1870 through 2010. Enrollments are expressed in both actual numbers and as percentages of the total population. During this 140-year period, college enrollments increased dramatically both in numbers and as shares of the total population, with the most rapid increase in enrollments occurring between 1950 and 1980.

Although interesting, this trend raises a number of questions. First, do the data on enrollments reflect demand, supply, or some combination of the two? For example, the enrollment growth after 1980 could reflect an increased interest on the part of students and their families in going to college (demand). But it could also reflect increases in the numbers of spaces made available to students in postsecondary markets (supply). There are a number of other forces at work on demand and supply that may have affected the numbers shown here. The United States experienced an increase in the population following World War II (i.e., the Baby Boom), which has had a rippling effect on the demand for many different goods and services including postsecondary education. This demographic trend can be seen in Figs. 5.1 and 5.2. Figure 5.1 shows how the number of births in the United States has fluctuated from 1960 to 2012. The number of births per year fell from 1960 through much of the 1970s as the larger Baby Boomer cohorts of children were replaced by smaller birth cohorts. Births then steadily increased over the next 15 to 20 years as the Baby Boomers began having children (i.e., the Baby Boomer Echo). The impact of this second wave of increased births is seen in Fig. 5.2, which shows how the number of high school graduates have changed over time. The number of high school graduates in the United States increased in the 1970s and 1980s as the Baby Boomers moved through the K-12 education system, and were eventually replaced by smaller graduating cohorts in the 1990s and early 2000s.

[4] Literature reviews of studies of demand for postsecondary education include Jackson and Weathersby (1975), Radner and Miller (1975), Leslie and Brinkman (1987), W. Becker (1990), Paulsen (1990), Heller (1997), and Ehrenberg (2004).

[5] See, for example, Albert (2000), Canton and de Jong (2004), Fredriksson (1997), and Psacharopoulos and Soumelis (1979).

Table 5.1 Postsecondary enrollments in the United States, 1870–2010

Year	Postsecondary enrollments[a]	U.S. population[b]	Ratio: enrollments to population (%)
1870	52,286	38,558,371	0.14
1880	115,817	50,189,209	0.23
1890	156,756	62,979,766	0.25
1900	237,592	76,094,000	0.31
1910	355,213	92,407,000	0.38
1920	597,880	106,461,000	0.56
1930	1,100,737	123,076,741	0.89
1940	1,494,203	132,122,446	1.13
1950	2,444,900	152,271,417	1.61
1960	3,639,847	180,671,158	2.01
1970	8,004,660	205,052,174	3.90
1980	11,569,899	227,224,681	5.09
1990	13,538,560	249,438,712	5.43
2000	14,791,224	282,171,957	5.24
2010	20,427,711	310,232,863	6.58

Notes
[a]Source is *Digest of Education Statistics 2013*, Table 220
[b]Source is U.S. Census Bureau

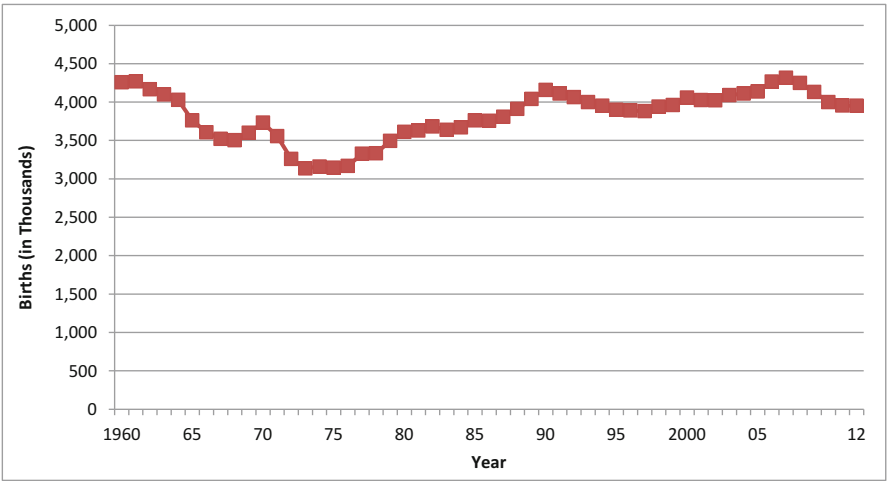

Fig. 5.1 Number of births in the US, 1960 to 2012 (*Source*: U.S. National Center for Health Statistics, Vital Statistics of the United States (http://www.cdc.gov/nchs/nvss.htm))

As will be explained later in this chapter, the demographic changes in the United States are an example of a shift in the demand curve for postsecondary education. Another demand-side change in postsecondary markets is that the G.I. Bill provided financial assistance in the 1940s and 1950s to war veterans to encourage them to go to college. In response, a number of colleges and universities expanded their

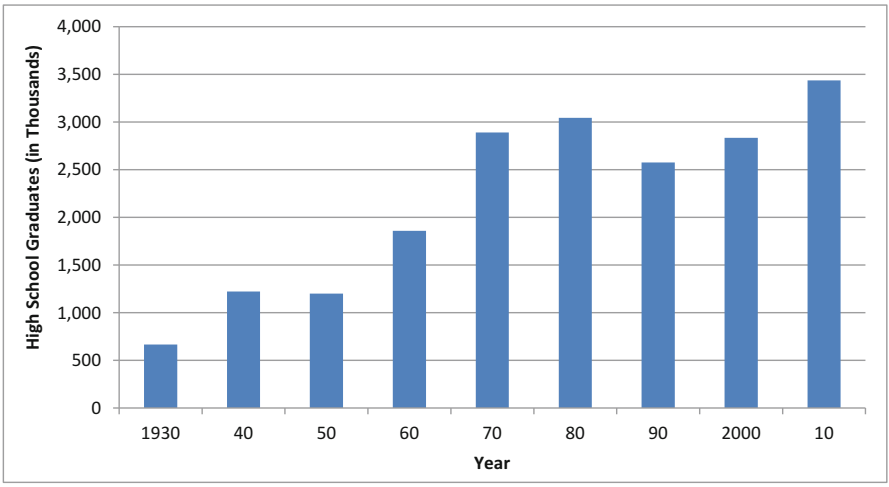

Fig. 5.2 Number of high school graduates in the US, selected years 1930 to 2010. (*Source*: *Digest of Education Statistics 2012*, Table 122)

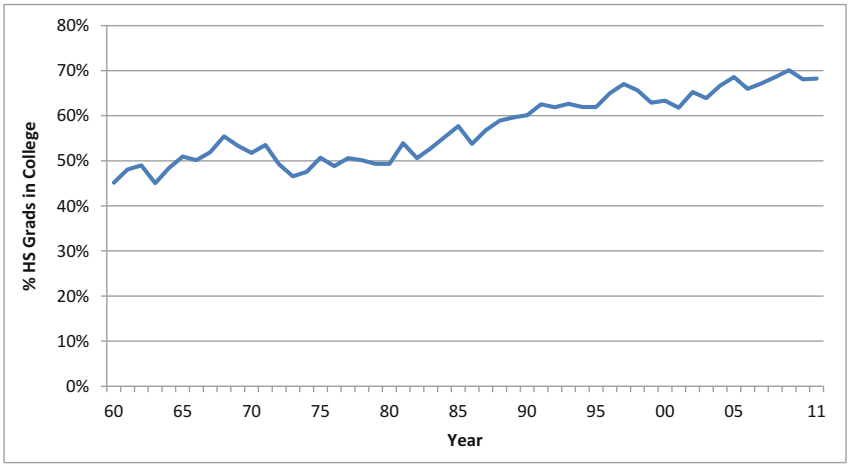

Fig. 5.3 Percent high school graduates enrolled in college, 1960–2011. *Notes*: Data were obtained from National Center for Education Statistics, *Digest of Education Statistics 2012*, Table 210. *Numbers* denote the percentage of recent high school graduates ages 16–24 enrolled in either a 2-year or 4-year institution by October of the year of graduation

campuses and grew in size and scope. Economists use the concepts of demand and supply to explore these and other related questions.

The effect of demographic trends on postsecondary education in the United States was magnified due to an increase in the college participation rate. Figure 5.3 shows the trend in another possible indicator of the demand for higher education: the proportion of recent high school graduates ages 16–24 enrolling in college after

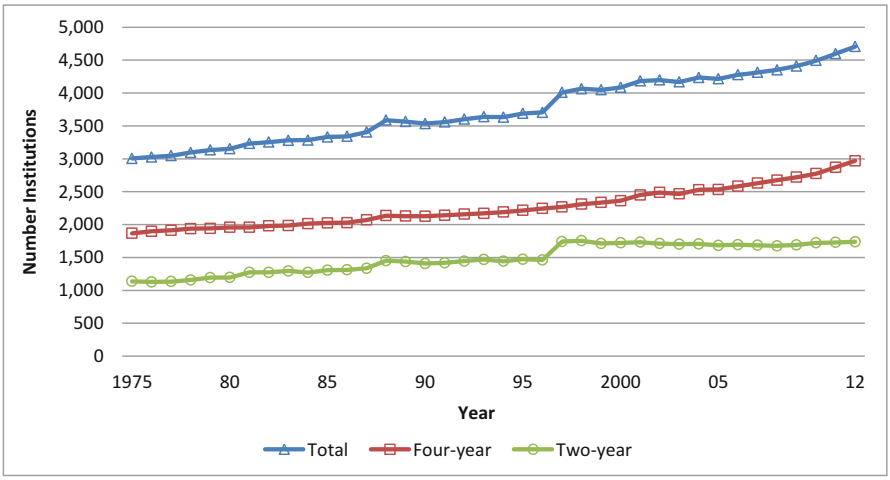

Fig. 5.4 Number of postsecondary institutions in the United States, 1975 to 2012 (*Source*: *Digest of Education Statistics 2013*, Table 279)

graduation. Roughly 50 % of the recent high school graduates enrolled in college between the years 1960 and 1980. Over the next thirty years, however, there was a steady increase in the share of high school graduates going to college, rising to 70 % by 2012.

During the time that demand for postsecondary education was rising, the United States also experienced an increase in the number of suppliers. Figure 5.4 shows how the number of postsecondary institutions has changed over time. It can be seen that there has been a gradual rise in the number of suppliers in postsecondary markets. Therefore, it is not clear whether the postsecondary enrollment growth was driven by increased demand or increased supply.

Demand for Higher Education

A *demand curve* describes the relationship between the price of a good or service and the amount of the good or service that consumers want to purchase. A demand curve can be thought of as a table or schedule showing the quantities of a good or service that consumers would be willing and able to purchase at a series of prices, holding all other factors such as income and the prices of other goods constant. The student's demand curve for postsecondary education is derived through the decisions made that would maximize their utility subject to their budget or income constraint.

To see how the demand curve originates, suppose that a student has to decide how to allocate her income between postsecondary education (*ED*) and a composite variable representing all other goods (*OG*) that she might purchase. The student has

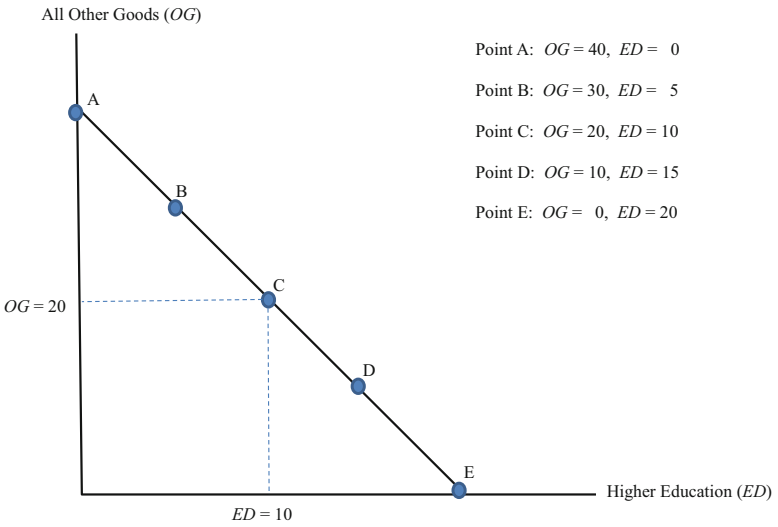

Fig. 5.5 Student's budget constraint. *Notes*: Figure assumes that the student has income of $I =$ \$40,000, the price of each unit of all other goods is $P_{OG} =$ \$1,000 and the price per unit of higher education is $P_{ED} =$ \$2,000

an initial budget line which is determined by her income level (I) and the prices per unit of postsecondary education (P_{ED}) and all other goods (P_{OG}):

$$I = P_{ED}ED + P_{OG}OG \tag{5.1}$$

The budget line for the student is depicted graphically in Fig. 5.5. We assume that the student has an income of $I =$ \$40,000, the price per unit of higher education is $P_{ED} =$ \$2,000 and the price per unit of the composite good is $P_{OG} =$ \$1,000.[6] The five points highlighted in the graph (labeled A through E) represent combinations of higher education and all other goods that the student could afford to purchase given her income. If the student were at point B, for example, then she would spend her entire income on five units of *ED* and 30 units of the composite good *OG*. The slope of the budget line is $-P_{ED}/P_{OG}$ and is the same at all points along the line. The slope can be thought of as the rate at which she is able to trade all other goods to get more postsecondary education. In this example, the slope of the budget line is $-$\$2,000/\$1,000 $= -2.0$, meaning that if she wants to purchase an additional unit of higher education, she has to give up two units of all other goods. Note that the budget line acts as a constraint on what the student can do with regard to higher education and all other goods consumed.

[6] A unit of higher education could represent a course, a credit hour, or a year of education. It is also common to make a simplifying assumption and group all other goods and services into one aggregate good and then focus on the single variable of interest on the X-axis.

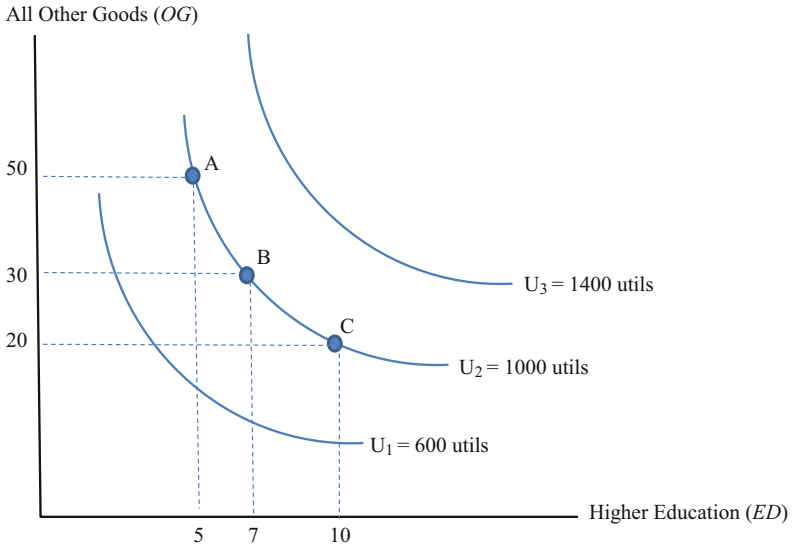

Fig. 5.6 Student's indifference curves for higher education

In the absence of constraints, the student has preferences for goods and services that are represented by indifference curves. For our example, an *indifference curve* shows the various combinations of higher education and all other goods that would give her the same level of utility or happiness. Three of these curves (labeled U_1 to U_3) are shown in Fig. 5.6. The student is assumed to have an infinite number of such indifference curves, with those to the right representing higher levels of utility. All of the combinations along the indifference curve U_3 give the student more utility than any of the combinations on curves U_1 and U_2. Using the indifference curve U_2 as an example, the student would be equally happy with—or indifferent between—the amount of higher education and all other goods at point A (50 units of *OG* and five units of *ED*) and the amount of higher education and all other goods at point B (30 units of *OG* and seven units of *ED*).

The slope of the indifference curve represents the rate at which the student would be willing to trade all other goods for more higher education. Unlike the budget line, indifference curves are not straight lines and as a result, the slope of the indifference curve is not constant and will depend on where the student is along the curve.[7] Going back to Fig. 5.6, if the student were initially at point A and wanted to move to point B, she would be willing to trade 20 units of *OG* to get two additional units of higher education. In moving from point B to C, however, her desired rate of exchange would be 10 units of *OG* for three units of *ED*. The rate of desired

[7] The specific shape of an indifference curve is due in part to the assumption that as the student consumes more of each good or service, her total utility increases at a decreasing rate. This means that there is diminishing marginal utility for both *ED* and *OG*, in that the student gets less and less added value as she consumes more of each good or service.

exchange is different for her at point B than it was at point A because she now has fewer units of *OG* (and is less willing to give them up) and more units of *ED* (and less interested in acquiring more). The slope of the indifference curve at any given point is called the marginal rate of substitution (*MRS*). If we write the student's utility function in a general form such as:

$$U = f(ED, OG) \tag{5.2}$$

then the *MRS* is the ratio of the marginal utilities for higher education and all other goods and can be calculated as:

$$MRS = -(MU_{ED}/MU_{OG}) \tag{5.3}$$

where $MU_{ED} = \partial U/\partial ED =$ marginal utility of higher education, and $MU_{OG} = \partial U/\partial OG =$ marginal utility of all other goods. Over a given range of the indifference curve, the average *MRS* can be estimated by $-\Delta OG/\Delta ED$, where $\Delta OG =$ units change in all other goods, and $\Delta ED =$ units change in higher education.[8] From Fig. 5.6, for example, the average *MRS* between points A and B is approximately $-20/2 = -10$. Note that $(\Delta OG/\Delta ED)$ is nothing more than the rate at which the student would want to exchange *OG* for *ED* without reducing her total level of satisfaction or utility.

The problem facing the student is how much postsecondary education and all other goods should she consume. Her goal in this model is to maximize her utility without exceeding her income. Economists have shown that this point occurs where the slope of the budget line is equal to the marginal rate of substitution, and all income is spent. In Fig. 5.7, this translates into the student choosing to consume $ED = 10$ units of higher education and $OG = 20$ units of everything else (point C). At this point, the rate at which she is willing to trade all other goods to get more higher education is equal to the rate at which she is actually able to do so given her income and the prices of higher education and all other goods. Even though she would prefer other combinations such as point A to point C, she cannot afford them because the combination of *ED* and *OG* at point A exceeds her income. Likewise, although both points C and E are affordable for the student, she would prefer to be at point C because she would get more utility from this combination.

The optimum point can also be found mathematically by combining the student's utility function and budget line into a mathematical function (L) such as the following:

$$L = f(ED, OG) + \tau(I - P_{ED}ED - P_{OG}OG = 0) \tag{5.4}$$

[8] The slope of the indifference curve at a specific point shows the change in one good due to a very small change in the other good. The approximation shown here is actually the slope of a straight line connecting the two points on the indifference curve, which may differ from the slopes of the curve at specific points along this interval.

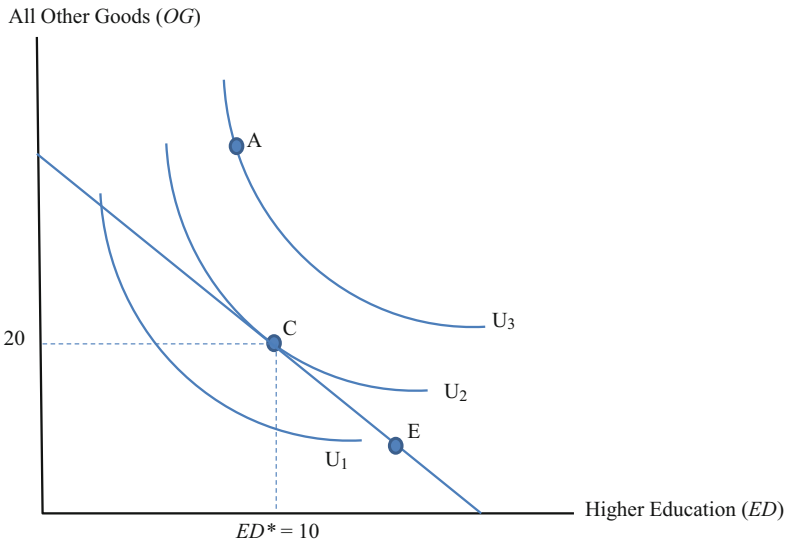

Fig. 5.7 Student's optimization of higher education. *Notes*: Figure assumes that the student has income of $I = \$40{,}000$, the price of each unit of all other goods is $P_{OG} = \$1{,}000$ and the price per unit of higher education is $P_{ED} = \$2{,}000$

where all variables are defined as before.[9] Calculus can then be used to find the values of ED, OG, and τ that maximize the function L.[10] In this model, the resulting utility-maximizing quantity of postsecondary education (denoted ED^*) would be written as a function of the prices per unit of higher education and all other goods, and the student's income level:

$$ED^* = f(P_{ED}, P_{OG}, I) \tag{5.5}$$

Assuming that the function $f(\ )$ relating prices and income to ED was known, the equation could be solved and the resulting optimum amounts of postsecondary education and all other goods would be determined.

The demand curve for higher education is identified (or derived) from this optimization process by observing how the equilibrium quantity of ED changes when the price of higher education changes, holding all else constant. Accordingly, the demand curve is a schedule showing all possible combinations of ED^* and P_{ED}

[9] The equation is referred to as a Lagrangian function where the problem is to optimize a function subject to a constraint. The symbol τ represents the shadow price of income, or the change in the Lagrangian function due to an increase in the income constraint. See the discussion in Chap. 2 for more information.

[10] More precisely, this is done by taking the first partial derivatives of L with respect to each of the three variables, setting the derivatives equal to zero, and then finding the values of ED, OG, and τ that make all of the equations true at the same time. It is common for applications to focus on the optimum quantities of ED and OG and not focus attention on the optimum value for the shadow price parameter.

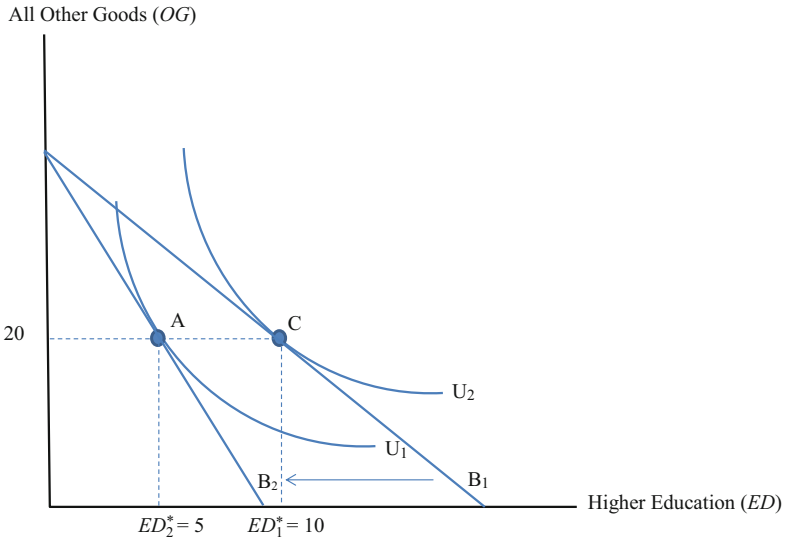

Fig. 5.8 Effects of price increase on student's optimization of higher education. *Notes*: Figure assumes that for the first budget line B_1 the student has income of $I = \$40{,}000$, the price of each unit of all other goods is $P_{OG} = \$1{,}000$ and the price per unit of higher education is $P_{ED} = \$2{,}000$. In the second budget line B_2, the price per unit of higher education increases to $P_{ED} = \$4{,}000$

that the student would choose at a given income level and price level for all other goods. To see this, suppose that the price of higher education in our example increased from $P_{ED} = \$2{,}000$ to $P_{ED} = \$4{,}000$. If we did not change the student's income or the price per unit of all other goods, then the higher education price increase would cause the student's budget line in Fig. 5.8 to pivot inward along the X-axis from point B_1 to B_2. At the higher price for postsecondary education, the student could no longer consume the same amounts of *ED* and *OG* as before because she would exceed her income. Repeating the optimization exercise from before at the new price for higher education would lead her to choose 20 units of *OG* and five units of *ED*. The new equilibrium is shown graphically at point A where the budget line B_2 is tangent to one of her indifference curves.

To find the student's demand curve for higher education, the utility-maximizing exercise shown above would be repeated for a series of prices and the resulting combinations of (ED^*, P_{ED}) would be recorded. The demand curve for postsecondary education is shown graphically in Fig. 5.9 by plotting the prices of higher education on the vertical axis and the quantities of higher education demanded on the horizontal axis.[11] In this example, points A and C correspond to

[11] The convention of placing price on the vertical axis and quantity on the horizontal axis is somewhat unusual. It is common to put the dependent variable on the vertical axis, and yet quantity is described as being dependent on price and not vice-versa. The early depictions of demand and supply, however, had price on the vertical axis and the practice has continued to this day.

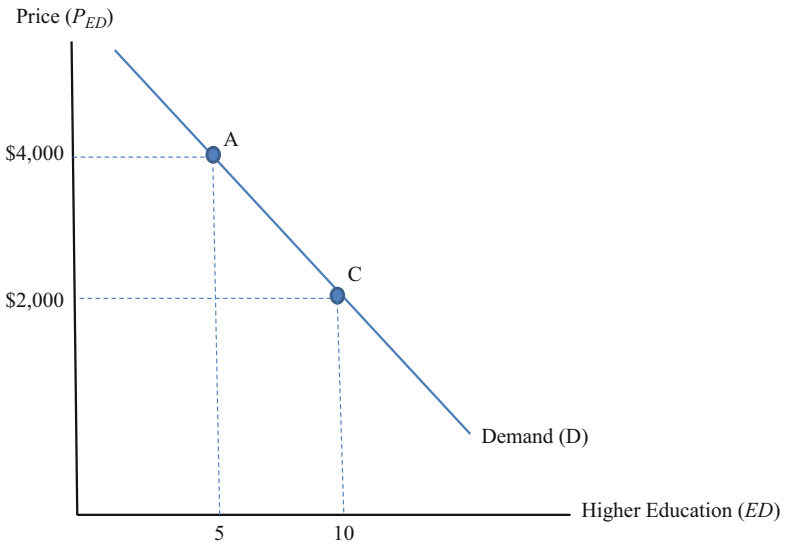

Fig. 5.9 Student demand for higher education

two utility-maximizing combinations of the price of the k-th college and the student's demand for attending the college. At point C, if the price was $2,000 per unit of higher education, then the student would choose ten units of higher education. If the price per unit doubled to $4,000, however, the student would demand only five units of higher education.

It is useful to think of the utility-maximizing amount of higher education shown in Eq. (5.5) as being similar to the latent demand for higher education discussed in Chap. 3. Recall that the student's latent demand for considering the k-th institution was a function of the price of the k-th institution and a series of other factors, as in:

$$a_{jk}^{*} = f\left(I_k^g,\ I_k^{ng}, I^{na}, \pi_k^g, \pi_k^r, T^1, T^r, T, tx^g, tx^{na}, P_k, F_k, w, z, i, Y, X\right) \tag{5.6}$$

If any of these variables were to change, they would also change the latent demand for the k-th college. To express this as a demand function for the k-th institution, we would find the values of a_{jk}^{*} for the student at a series of prices P_k, holding constant all other variables in the equation. This can be written mathematically as follows:

$$a_{jk}^{*} = f\left(P_k \middle| I_k^g,\ I_k^{ng}, I^{na}, \pi_k^g, \pi_k^r, T^1, T^r, T, tx^g, tx^{na}, F_k, w, z, i, Y, X\right) \tag{5.7}$$

where the vertical line "|" indicates that all variables to the right of the line are assumed to be fixed or held constant. A similar approach could, of course, be used for the predisposition for going to college (a_j^{*}) and the demand for applying to a

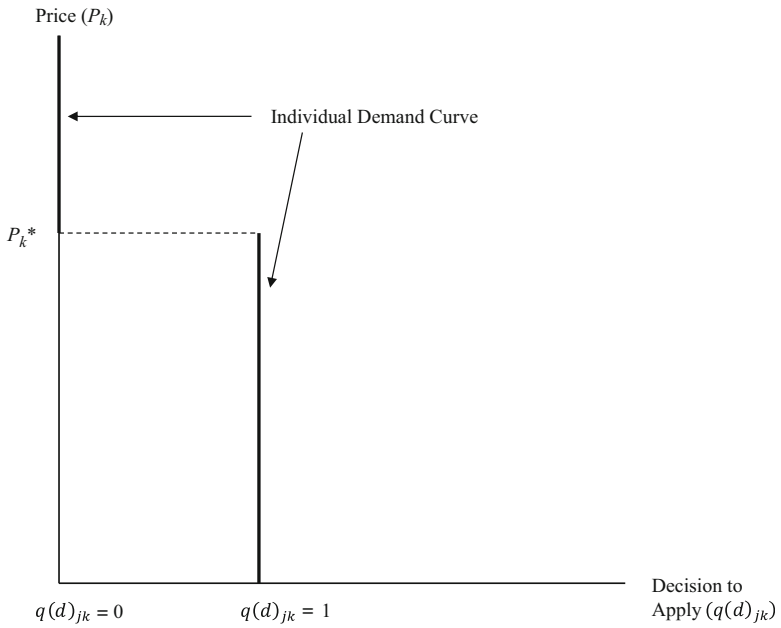

Fig. 5.10 Observable individual student demand for a single institution

specific institution ($q(d)^*_{jk}$). The individual student's unobservable demand curve for applying to the k-th institution can be thought of as the values of $q(d)^*_{jk}$ corresponding to a series of prices (P_1,. . .,P_n), holding constant all other factors that can affect $q(d)^*_{jk}$. The resulting demand curve would be continuous (either a straight line or a curve).

Latent demand curves are useful as a theoretical construct, but they cannot be directly observed. However, due to the dichotomous nature of the application variable (the student either applies or does not apply to the k-th institution), the demand curve that can actually be observed is a discontinuous vertical line that switches from not applying ($q(d)_{jk} = 0$) to applying ($q(d)_{jk} = 1$) once the price of attending college becomes sufficiently low.[12] This is depicted in Fig. 5.10.

We can use this same general approach to find the individual's unobservable and observable demand curves for considering postsecondary education, which correspond to Stage 1 of the five-stage college choice model in Chap. 3. The student's unobservable demand for higher education, for example, are the values of a^*_j that align with a series of prices of higher education holding all else in the demand equation constant. Likewise, the observable demand for higher education would be identified by finding the price P at which the student decides to pursue a college

[12] Because the dependent variable is dichotomous and bounded, one should use an appropriate statistical technique when estimating an individual-level demand curve.

education, and plotting this in a similar way as in Fig. 5.10. Similarly, the same kind of demand curves could be specified for the second stage of the college choice model as to whether to include an institution in the initial choice set. A continuous line/curve is used for the latent demand for considering a specific institution, and the discontinuous vertical line demand curve shows how changes in the price of the k-th college affect whether or not a student actually includes the institution in his or her choice set.

Market Demand for Postsecondary Education

The derivation of the demand curves for higher education shown above focuses on the decisions of a single student. Of course, higher education markets consist of a large number (J) of students, each of whom must decide at what price they decide to go to college, consider an institution, or apply to an institution. The sum of the demands for all students who are faced with these options within a set of competitors represents the market demand. The market demand curve is a schedule showing the numbers of students who would make each of these decisions at a series of prices, holding all else constant. We use $Q(d)_k = \sum_{j=1}^{J} q(d)_{jk}$ to represent the total number of students who applied to the k-th college. The same approach could be used to represent the number of students who decide to include a specific college in their initial choice set, or the number who enrolled at the institution. The market demand curve for the institution is therefore affected by all of the same factors that influence an individual student's demand curve, as well as the number of individuals in the respective market.

We further use $Q(d) = \sum_{k=1}^{K} \sum_{j=1}^{J} q(d)_{jk}$ to denote the aggregate demand for applying to institutions in a market, where the demands for the K institutions in the relevant market are summed to obtain the total. For example, if a researcher were interested in the market for public 4-year universities in Michigan, then $Q(d)$ represents the total demand for the 16 public 4-year universities in the state. Likewise, this construct could be used to find the total demand for initially considering institutions within a given set of competing institutions.[13]

Because students vary in terms of the utilities they attach to college and the components of the expected costs and benefits from attending college, they will have different "tipping points" at which the price becomes low enough that they decide it is in their best interest to either consider college, include an institution in their choice set, or apply to an institution. A simple illustration of this is shown in Fig. 5.11, where we assume that the postsecondary market consists of four students.

[13] There are instances where economists will want to avoid double-counting students for a designated market who have considered or applied to multiple institutions.

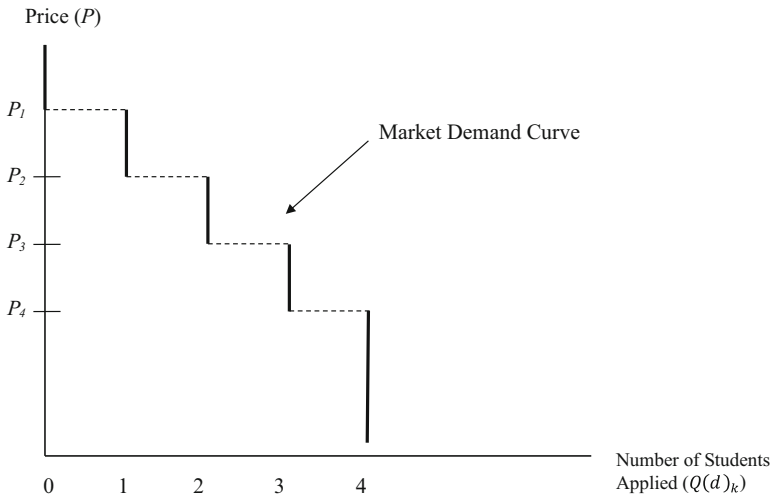

Fig. 5.11 Observable market demand for a single institution

The individual demand curves for the four students are summed to obtain their aggregate demand. In this figure, no student would be willing to apply to the college if they had to pay more than P_1, one student would apply if the price was between P_1 and P_2, two students would apply if the price was between P_2 and P_3, three would apply at prices between P_3 and P_4, and all four students would apply at any price below P_4. The negative relationship between the price of the institution and the quantity demanded is known as the law of demand.

The market demand curve is important for the economics of higher education because price (tuition) and quantity (enrollments) in the relevant market are set by the intersection of market demand and supply as opposed to the demand and supply curves for a single consumer or producer. Because markets typically include a large number of consumers, it is more convenient to depict the market demand curve for higher education by a straight line or a curve (see Fig. 5.6) rather than by the staircase pattern in Fig. 5.11.

Changes in Quantity Demanded

It is important to understand the distinction that economists make between a change in the quantity demanded and an overall change or shift in demand. A *change in quantity demanded* represents a movement from one point on the demand curve to another. The only way in which the quantity of postsecondary education demanded may change is if the price changes and all else is held constant. This is depicted graphically in Fig. 5.12. Point A shows that at the price of $15,000, there would be a total of 8,000 students who would be willing and able to attend the institution. If the

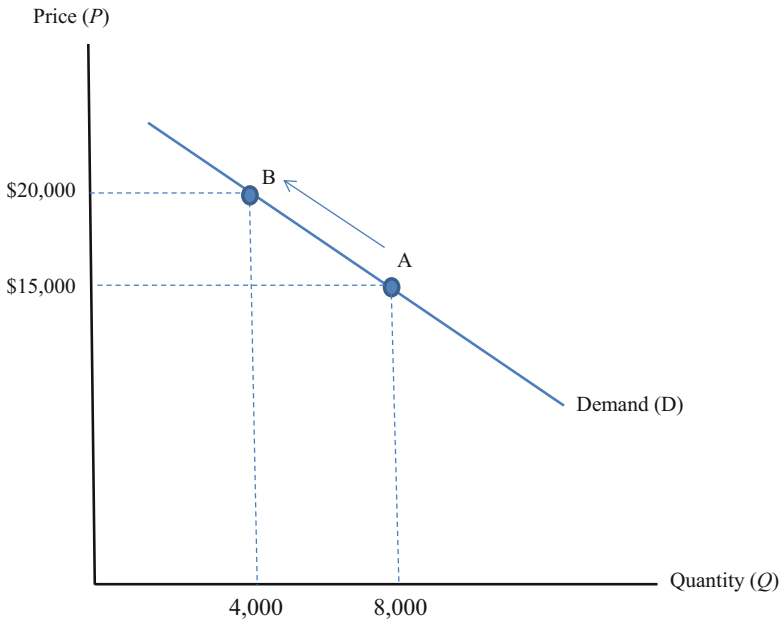

Fig. 5.12 Change in quantity demanded of postsecondary education

institution were to increase its price to $20,000, however, then only 4,000 students would be willing and able to attend. Therefore, the $5,000 price increase led to a *change in quantity demanded* of −4,000 students. The height of the demand curve indicates the maximum price that each student and their family would be willing and able to pay for college. The 4,000th student represented by point B, for example, would pay up to $20,000 to attend this institution, and likewise the 8,000th student would pay a maximum of $15,000.

Changes in Demand

The demand curve shown in Fig. 5.12 is constantly changing position due to forces in the postsecondary education market. When the demand curve moves from one location to another, it is referred to as a *change in demand*. For a change in demand to occur, one of the non-price factors in the demand model would have to change. There are two types of changes in demand: increases in demand and decreases in demand. An increase in demand happens when the demand curve shifts upward and to the right from D_1 to D_2, as shown in Fig. 5.13. As a result of the increase in demand, the quantities demanded at each price would rise. For example, if the price of postsecondary education was $20,000, then at point A along the original demand curve there would be 4,000 students willing and able to attend the institution.

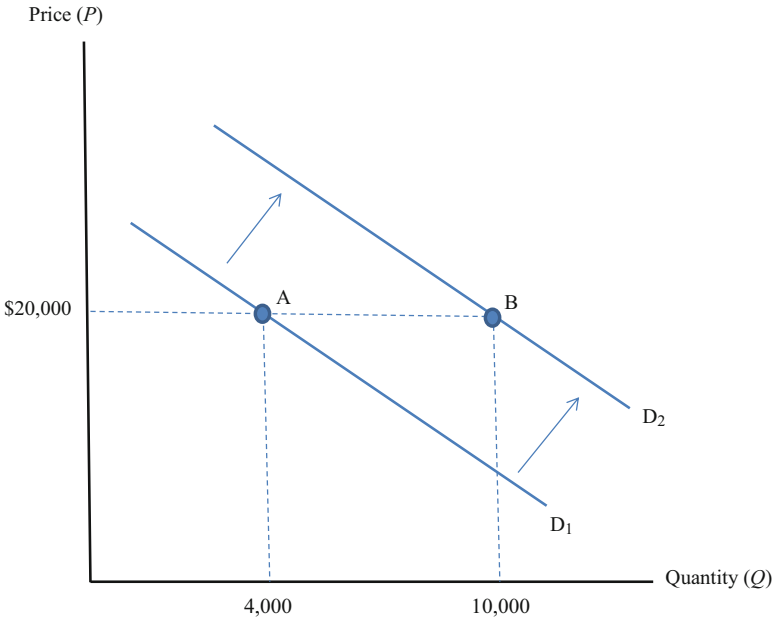

Fig. 5.13 Effect of increase in market demand on quantity

However, if the demand curve shifts upward and to the right to the position D_2, then at the same price there would now be 10,000 students willing and able to attend the institution. The demand curve could also shift downward and to the left, which is referred to as a decrease in demand.

What factors could lead to a change in demand? In general, demand curve shifters would include any variable that was assumed to be held constant when the market demand curve was formed. This would include factors such as the incomes of students and their families, the prices of competing institutions, the consumptive benefits of college, and the number of students in the market. In fact, all of the variables to the right of the conditional line "|" in Eq. (5.7) (and similar demand equations for a_j and $q(d)_{jk}$) are demand curve shifters. How far changes in each variable would shift demand depends on the relationship between each variable and demand.

Of particular interest to economists is the effect of changes in income on the demand curve. Whether changes in income lead to an increase or decrease in demand depends on whether postsecondary education is a normal good or an inferior good. If demand rises when incomes increase, then the postsecondary option being considered is a *normal good*. Likewise, an *inferior good* is one for which increases in income lead to decreases in demand. How income changes affect postsecondary demand depends on the student's initial income level and the type of institution being considered. As incomes rise, students and their families are better able to pay the prices charged by colleges. For example, before any increase in

income, a student from a lower-income family may have been unable and unwilling to go to college; however, an increase in income may enable him or her to now consider going to a 2-year college where tuition rates are relatively low. For a middle-income student, an income increase could help him or her afford to go to an in-state 4-year institution instead of a 2-year institution. Upper-income students, on the other hand, may find that an income increase permits them to substitute away from 4-year in-state public institutions and towards out-of-state public institutions or even private institutions where tuition rates are relatively high.

The tuition rates charged by other institutions will have a positive effect on the demand for the institution in question as long as the institutions are viewed as being substitutes for each other. As the tuition rates at competitors rise, holding all else constant, the relative price of going to the college being examined will fall. For example, if Iowa State University were to increase its tuition rate, then this may cause more students to consider attending the University of Iowa because for many students these two institutions are in the same postsecondary market and compete with each other for students. In contrast, tuition increases at a community college in Oregon are unlikely to affect demand for the University of Iowa because they do not compete in the same markets for most students.

To illustrate the effects of income and competitor's price on demand, suppose that the market demand curve for applying to College A is found to be the following:

$$Q(d)_A = 2,000 - 1.5P_A + 0.3P_B + 0.8I \tag{5.8}$$

where $Q(d)_A$ = number of students in the market who apply to college A, P_A = price of college A, P_B = price of a competing College B, and I = average incomes of students and their families. In Table 5.2, the first column shows six different tuition rates that could be charged by College A. When combined with the numbers in the second column, the pairs of values (P_A, $Q(d)_A$) represent points along the initial demand curve when the competitor's price is P_B = \$10,000 and the average incomes of students and their families is I = \$40,000. Due to the negative slope of the demand curve (which is the coefficient −1.5 for the variable P_A in Eq. 5.8), as the price of College A rises by \$100 holding P_B and I constant, applications to College A (quantity demanded) would fall by 150 students. Moving from one row to the next in this table illustrates changes in quantity of postsecondary education demanded because the only factor that changed was the price of College A.

Now, suppose that the average incomes of students and their families (a non-price factor) were to rise by \$20,000 to a new value of \$60,000, and the price of College B is held constant at P_B = \$10,000. Because the coefficient for average family income (+0.8) is positive, the increase in family incomes will lead to more applications at each of the six prices shown in the table. In this instance, the \$20,000 increase in average incomes will result in 16,000 more applications at each price. As a result, the demand curve for applying to College A would shift upward and to the right and we would say that there has been an increase in demand. The

Table 5.2 Example of change in demand for college A

Price of college A	Quantity of applications ($Q(d)_A$)[a]	If average income rises to \$60,000:[b]		If competitor's price falls to \$6,000:[c]	
		Quantity of applications ($Q(d)_A$)	Change in demand	Quantity of applications ($Q(d)_A$)	Change in demand
\$1,000	35,500	51,500	+16,000	34,300	−1,200
\$3,000	32,500	48,500	+16,000	31,300	−1,200
\$5,000	29,500	45,500	+16,000	28,300	−1,200
\$10,000	22,000	38,000	+16,000	20,800	−1,200
\$15,000	14,500	30,500	+16,000	13,300	−1,200
\$20,000	7,000	23,000	+16,000	5,800	−1,200

Notes: Quantity of applications to College A are determined by the demand equation: $Q(d)_A = 2,000 - 1.5P_A + 0.3P_B + 0.8I$.

[a]It is assumed that the price of College B is $P_B = \$10,000$ and the average income of students and their families is $I = \$40,000$

[b]All parameters are the same as in the first equation, except that income is increased to $I = \$60,000$

[c]All parameters are the same as in the first equation, except that the price of College B is reduced to $P_B = \$6,000$

positive coefficient for income indicates that on average College A is viewed as a normal good by consumers.

Similarly, the last two columns show what would happen if the competing institution lowered its price to $P_B = \$6,000$, and average family income was held constant at the original value $I = \$40,000$. The fact that the coefficient for the competitor's price (+0.3) is positive shows that the two colleges in question are viewed on average as substitutes in the relevant higher education market. The price reduction for the substitute good reduces the number of applications that College A would receive at each price by 1,200 students. Therefore, the demand for College A has shifted downward and to the left, resulting in a decrease in demand.

There are other variables that may also cause the market demand for postsecondary education to shift. Recall that the market demand curve is the sum of all of the individual-specific demand curves for students in the market. Therefore, as more students enter a given postsecondary market, holding all else constant, it would lead to an increase in demand and vice-versa. For example, in the 1990s and continuing through the first decade (and more) of the twenty-first century, there was an increase in the number of students graduating from high school. The larger graduating classes translated into an increase in demand for higher education. In addition, the demand curve for considering the k-th college (shown in Eq. 5.7) shows that incomes by degree level, time spent in college and the labor market, the probability of graduating, financial aid received, and the other factors on the right-hand side of the equation all impact demand. Revisiting the concept of comparative statics from Chap. 3, one may be able to determine if increases in each factor of interest would be predicted to cause demand to rise or fall.

Supply of Postsecondary Education

The demand curve focused on the decisions made by the consumers of postsecondary education, namely students and their families. These individuals constitute only one half of higher education markets. Postsecondary education markets also consist of a supply side, which represents the entities that make these educational services available to students and their families. Each college must make decisions about the levels and types of services that they want to provide to their market. Although these services could include research, teaching, and/or public service, we focus here on the supply decisions relating to teaching or instruction-related services and how these are reflected in the number of students served.

An important feature of supply decisions in postsecondary markets is the time frame in which price and quantity supplied are determined. Colleges and universities typically decide in the spring what price to charge and how many students to enroll for the following academic year.[14] Therefore, price and quantity are fixed during any specific academic year regardless of changes in factors that could affect supply decisions. Nonetheless, even in non-education markets there is a period of time during which the supplier has a specific price that they charge customers and a specific quantity of the good or service that they are willing and able to sell at that price.

The *supply curves* for institutions in higher education in a given year ("short-run") generally fall into one of two categories, as depicted in Fig. 5.14. The graph on the left shows the short-run supply curve for an institution that would enroll as many students as wish to attend at the stated price. These institutions are often referred to as "open admission institutions." In contrast, the graph on the right illustrates the case where the college has set an enrollment target and will only enroll students up to this limit regardless of price. These institutions where enrollments are fixed can be thought of as "selective admission institutions." Usually, the selective admission institutions are those that benefit from having more applicants who are willing and able to pay the price to attend than the institution has space to accommodate in the short run or that the institution needs to help finance its operations.

Given enough time, however, institutions of higher education can vary the supply of spaces offered to students depending on a range of factors, including the price that they charge. Therefore, the long-run supply curve for the market would be an upward-sloping line or curve showing the relationship between price and quantity of spaces supplied. Microeconomic theory suggests that over a multi-year period the quantity of services supplied by the k-th institution ($Q(s)_k$) will be a function of the price of the service, the price of resources needed to provide services

[14] Of course there are exceptions to this pattern, primarily for 2-year and not-for-profit institutions that may vary pricing and supply decisions from term to term.

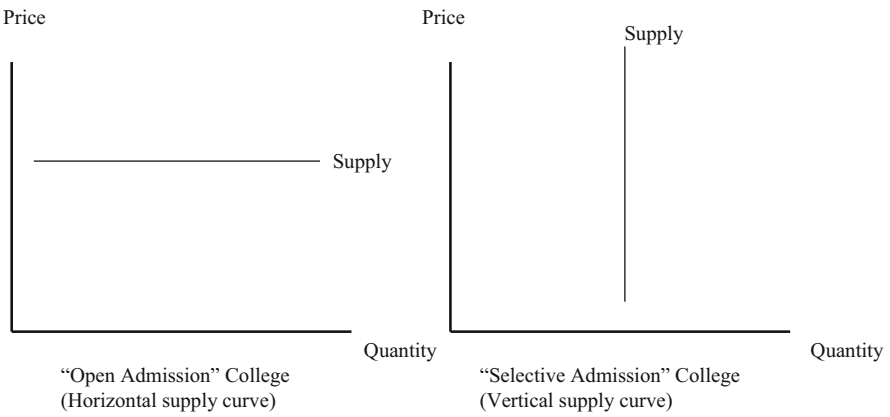

Fig. 5.14 Short-run supply curves for open admission and selective admission institutions

(R), the state of technology for producing services (H), and any governmental and other subsidies received by the institution (G):

$$Q(s)_k = f(P_k, R_k, H_k, G_k) \tag{5.9}$$

The quantity of postsecondary services supplied may be thought of as the number of places that the institution is willing to provide to students. The prices of resources would include things such as salaries and benefits for faculty and staff, and the cost of equipment and services. The state of production technology available would, for example, encompass the student-faculty ratio or use of distance-delivery technology in the provision of college learning experiences. Finally, the subsidies to producers would include state or local government appropriations to public institutions, as well as donative resources acquired by public and private institutions through fund-raising, endowment income, and so on.

Each of these factors on the right-hand side of Eq. (5.9) can have an important influence on the quantity of enrollment places institutions are willing to make available. For example, all else held constant or equal to its current value, a higher price (P) would increase the number of places institutions are willing to provide or supply to students. This is known as the *law of supply*. All else equal, higher salaries for administrators or faculty (R) would lead to decreases in the quantity of enrollment places supplied. Colleges and universities using a larger student-to-faculty ratio or offering a larger share of its coursework via distance technology (H) are more likely than other institutions to have lower per-student costs of production and supply larger quantities of enrollment places, all else held constant. Similarly, all else equal, higher per-student subsidies to help cover the institution's costs of educating students (G) would tend to increase the quantity of enrollment places institutions of higher education are willing to supply.

As with demand, we can talk about the supply for an individual institution or the supply for a group of institutions in the same market. When the focus is on one

institution (such as the University of Connecticut), Eq. (5.9) represents the relevant supply equation. In contrast, if one defines a market as the set of institutions that compete with each other for students and resources, such as the set of Ivy League institutions or the set of four-year institutions offering master's degrees in economics, then the relevant supply will be the sum of the supplies for the institutions in this market (i.e., $Q(s) = \sum_{k=1}^{K} Q(s)_k$). The market supply in this case will be affected by all of the factors that influence the supply decisions for each institution, as well as the number of institutions in the market.

Changes in Quantity Supplied

The (long-run) supply curve shows the quantities of students that would be accommodated by institutions in the market at a series of prices, holding all other factors in the supply equation constant. The supply curve can be expressed in algebraic form by rewriting the quantity supplied equation as:

$$Q(s)_k = f\left(P_k \middle| R_k, H_k, G_k\right) \tag{5.10}$$

where the vertical line "|" again denotes that everything to the right of the line is assumed to be held constant. The concept of a supply curve can also be applied to the fourth stage of the college choice model where institutions make decisions about which students to admit, and each of the non-price factors in the equation represent supply curve shifters.

As with demand, economists are careful to distinguish between changes in quantity supplied and changes in supply. When there is a change in the price of the postsecondary option of interest, it leads to a *change in quantity supplied* which is shown as a movement along a given supply curve. This is shown in Fig. 5.15 where a price increase from $15,000 to $20,000 leads to an increase in the number of students that institutions would be willing and able to enroll from 7,000 to 10,000. It is assumed in the chart that none of the other factors that could affect supply have changed. The height of the supply curve indicates the minimum price that colleges would need to receive to supply a given number of spaces to the market. At point A, for example, institutions would need to receive at least $15,000 to entice them to enroll the 7,000th student, and would need even more ($20,000) to enroll the 10,000th student at point B.

Changes in Supply

On the other hand, when one of the non-price factors that can influence supply does indeed change from its current value, it will result in a shift in the entire supply

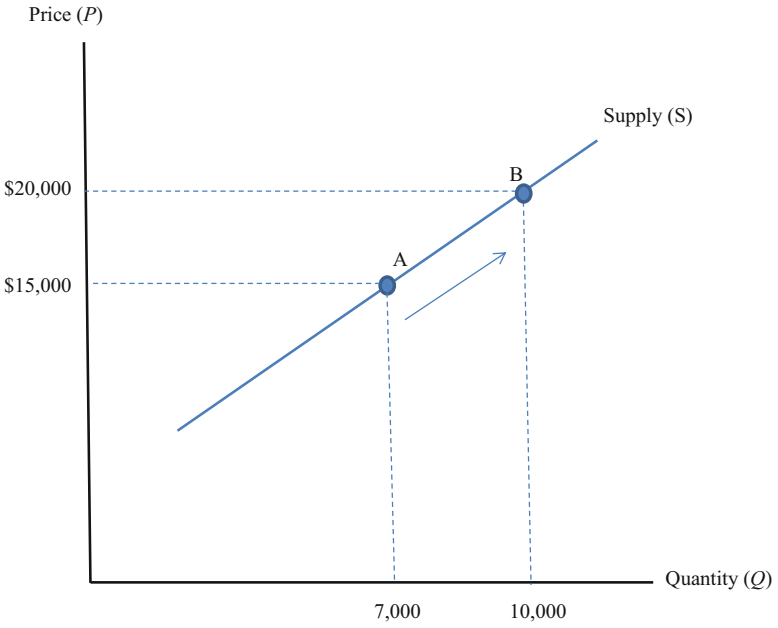

Fig. 5.15 Change in quantity supplied of postsecondary education

curve. This is referred to as a *change in supply*. The supply curve may either shift downward and to the right (increase in supply), or upward and to the left (decrease in supply). When there is a decrease in supply, as shown in Fig. 5.16, the quantities of postsecondary education supplied at each price will fall. To illustrate, suppose that the price of college was $20,000. According to the original supply curve S_1 there would be $Q(s) = 10{,}000$ spaces made available for students. If something were to change a non-price factor in a way that would lead to a decrease in supply, then the entire curve may move to a new location as denoted by S_2. At the same price as before ($P = \$20{,}000$), only $Q(s) = 5{,}000$ spaces would now be available for students. An increase in supply would lead to the opposite shift in the supply curve.

Equilibrium in Postsecondary Markets

Markets provide a mechanism for setting prices and output for the good or service in question. Economists dating back to Cournot (1838) have stressed that prices and output depend on both demand and supply, in that a market brings together (either physically or virtually) demanders and suppliers of the good or service. The same is true in higher education markets, where demand and supply determine the tuition rate at which the number of students who want to go to college equals the number of

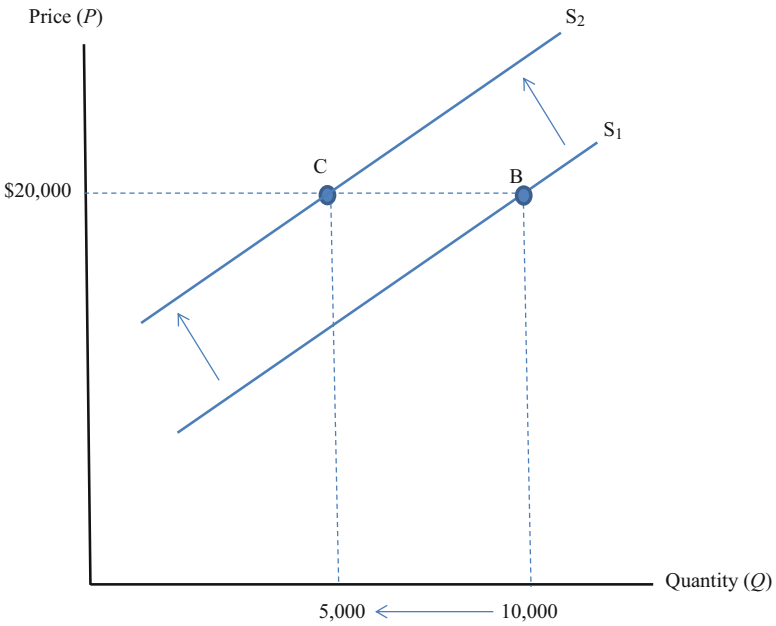

Fig. 5.16 Decrease in supply of postsecondary education

spaces that institutions are willing to provide. The market demand and supply curves can now be combined to find the market-clearing, or equilibrium, price charged for postsecondary education and the number of students who would enroll at this price.

The equilibrium is shown graphically as the point where the market demand and supply curves intersect, as in Fig. 5.17. The market demand and supply curves in this example intersect at point A ($P = \$15{,}000$, $Q = 7{,}000$), meaning that if the price was set equal to $15,000, the number of students who would be willing and able to enroll in college would be the same as the number of spaces institutions would be willing and able to provide. If the price was set above equilibrium (such as $P = \$20{,}000$), then institutions would provide more spaces than students would be willing to fill. This would result in an excess supply of spaces in the market. Institutions would have an incentive to reduce their prices to help fill the empty seats, and thus there would be a downward pressure on prices towards the equilibrium value. The opposite would happen if prices were below equilibrium. In our example, a price of $P = \$10{,}000$ would entice many more students to go to college than institutions would be willing to accommodate, leading to an excess demand in the market. The excess demand would place upward pressure on prices until the equilibrium value is attained. According to Adam Smith, it is as if an "invisible hand" is constantly moving market prices towards equilibrium.

It is helpful to note that both the demanders and suppliers benefit from the equilibrium price. Recall that the height of the demand curve shows the maximum

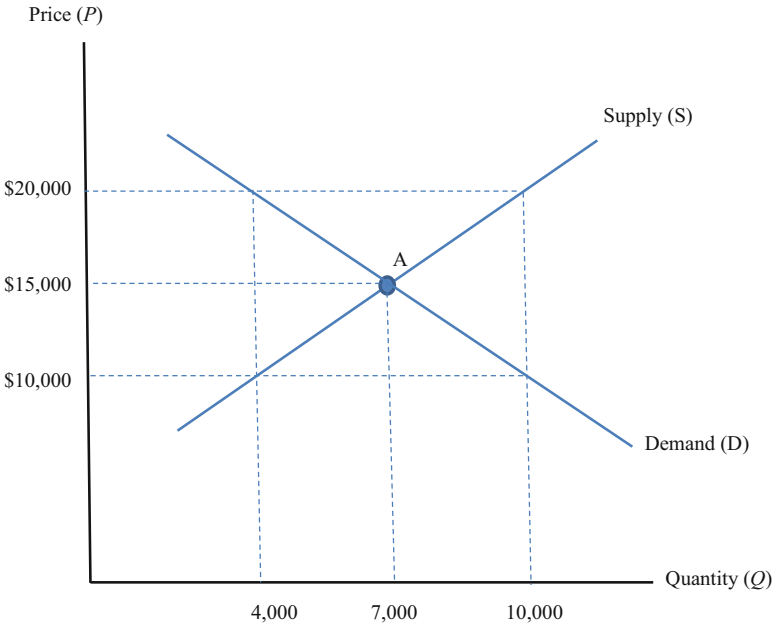

Fig. 5.17 Equilibrium in a postsecondary education market

that each student would be willing to pay for a postsecondary education. Instead of paying their maximum prices, however, students pay the lower equilibrium price and therefore receive a benefit (known as consumer surplus) from the vertical distance above the equilibrium price and below the demand curve. Likewise, suppliers get a benefit from receiving the equilibrium price per student rather than the minimum amounts they require to offer the space. This additional value (known as producer surplus) is the vertical distance above the supply curve and below the equilibrium price.

Changes in Equilibrium

Postsecondary markets are rarely stable or static. Whenever the demand or supply curves in a market shift, they lead to a new equilibrium price and quantity. The many factors that affect demand and supply are constantly changing, creating pressures on prices and output. Of course, the change to a new equilibrium is not instantaneous. Time is required for the impact of the factor to be felt on demanders and/or suppliers, and with multiple shifts occurring at the same time, equilibrium is perhaps best described as a constantly moving target rather than a static point as depicted in Fig. 5.17.

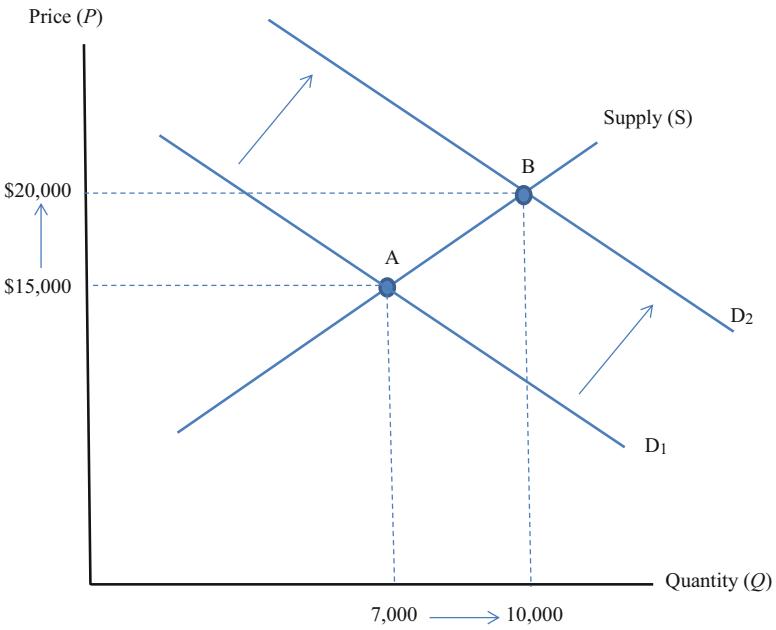

Fig. 5.18 Effect of increase in demand on equilibrium in a postsecondary market

When changes in a non-price demand or supply factor result in a new equilibrium, economists use demand and supply theories to compare the two different states of market equilibrium—one before and one after the market changes. The comparison of different market equilibria before and after such market changes is referred to by economists as comparative statics (see discussion in Chap. 2). Suppose that the postsecondary market in Fig. 5.18 is in equilibrium at point A. At this point, the going rate for postsecondary services is $15,000 and 7,000 students would be enrolled. If something were to occur that would cause the demand curve to shift upward and to the right, then the increase in demand would lead to a new equilibrium at point B, where the market-clearing price is higher ($P =$ $20,000) and 10,000 students would enroll. The movement from point A to B would not happen right away, but rather there would be pressure over time for prices to rise. It should be noted that the change in demand shown in Fig. 5.18 leads to a change in quantity supplied because it results in a movement from one point to another along the supply curve.

As another example, suppose that the postsecondary market in Fig. 5.19 experiences an increase in supply due to an improvement in the productivity of faculty. The supply curve moves from its current location at S_1 to a new location at S_2. Due to the increase in supply, the equilibrium price in the market falls and the equilibrium quantity rises. At the equilibrium point B, the new market-clearing price is $11,000, at which 9,000 students would be willing and able to enroll. The change in supply in this example is also interpreted as a change in quantity demanded because

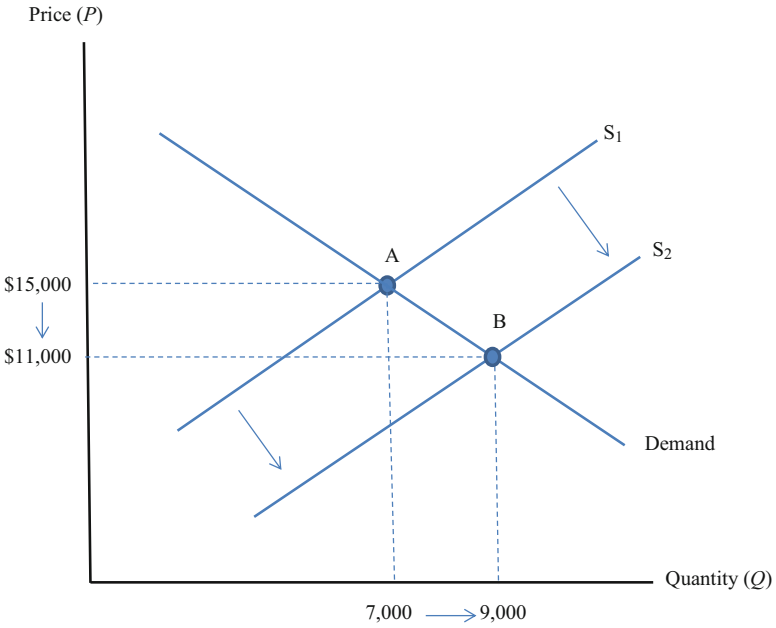

Fig. 5.19 Effect of increase in supply on equilibrium in a postsecondary market

the shifting supply curve leads to a movement along the demand curve which has not changed its position.

Of course, it is entirely possible that both the demand and supply curves will shift at the same time. The resulting effect on price and quantity depends on the relative size of the changes in demand and supply. The concepts of demand, supply, and equilibrium are useful for projecting the direction of change in price and quantity in the postsecondary market due to a specific factor, holding all else constant.

Elasticity Measures in Postsecondary Markets

Economists are often interested in predicting not only the direction, but also the magnitude, of changes in quantity demanded or supplied when another factor changes. There are two basic approaches that can be used for this purpose. The most straightforward way to do this is to measure the unit change in quantity demanded or supplied due to a one-unit increase in the factor of interest. For instance, if the price of going to college increases by $1000, then how many more spaces would colleges supply to the relevant higher education market? These effects are captured by the slopes of the demand and supply curves. Although the slope is easy to interpret, a limitation with this approach is that it is not always

clear whether the resulting change in quantity is "large" or "small." If the number of applications to an institution were to fall by 400 due to a $600 tuition increase, for example, then this would be a big problem for a college that only receives 800 applications each year but a much smaller problem for a public land-grant institution that receives 20,000 or more applications annually.

To address this limitation, economists often focus on the percentage change in quantity that is caused by a percentage change in a specific factor. This concept is referred to in the broadest sense as an *elasticity*. To illustrate, if family incomes were to fall by 10 % due to a recession, then the demand elasticity would be based on the resulting percentage of students who would no longer be willing and able to go to college. The advantage of expressing sensitivity in terms of percentage changes is that the results can be readily compared across different examples since it is not affected by the units of measurement.

There are three general magnitudes of elasticity. When a one percent change in a factor leads to a greater than one percent change in quantity, then quantity is very responsive to the factor and is said to be elastic. Likewise, quantity is inelastic when a one percent change in the factor creates a less than one percent change in quantity. This means that quantity is not greatly influenced by the factor in question. Finally, quantity is unit elastic when a one percent change in the factor results in precisely a one percent change in quantity.

Own-Price Elasticity of Demand

Most often, economists focus on the sensitivity of quantity demanded to changes in the price of the good or service. This is referred to as the *own-price elasticity of demand* ($E(P_k)_d$) and is defined as the ratio of the percentage change in quantity demanded divided by the percentage change in the price of the good or service:

$$E(P_k)_d = \frac{\%\Delta Q(d)_k}{\%\Delta P_k} \tag{5.11}$$

where $\%\Delta Q(d)_k =$ percentage change in quantity demanded of the k-th institution, and $\%\Delta P_k =$ percentage change in the price of institution k. A key assumption of this formula to keep in mind is that all other factors that may affect demand are held constant. The larger the numerator of Eq. (5.11) relative to the denominator, the more elastic or sensitive students and their families are with respect to price changes. Provided that the demand curve has a negative slope, the resulting measures of elasticity will also be negative. Demand will be own-price elastic when $E(P_k)_d < -1$, inelastic when $0 > E(P_k)_d > -1$, and unit elastic when $E(P_k)_d = -1$.

There are a number of factors that can affect the own-price elasticity of demand across a wide range of types of goods and services. Two of the most common determinants of the price elasticity of demand for a product are: (a) the share of

household's budgets that a product's price accounts for, and (b) the number and closeness of substitute products available.

The share of income that the price of a product accounts for in household budgets is a very important determinant of elasticity. For example, tissues, paper towels or toothpaste all account for small portions of household budgets; therefore, even fairly large percentage increases in their prices will probably not lead to a large percentage reduction in quantity demanded—in other words, a relatively low own-price elasticity of demand would be expected for such products. On the other hand, products such as houses, new cars, or four years of college are big-ticket items that account for large portions of household budgets. Therefore, all else equal, the own-price elasticity of demand for products and services such as these would be somewhat larger than for services that are only a small portion of a person's budget.

The number and closeness of substitutes for a product available sometimes depends on how the market for a specific product is defined. For example, a 20 % increase in the price of gasoline sold at one station would produce a very large percentage decrease in its quantity demanded, because consumers can easily purchase very close substitutes at other stations. However, a 20 % increase in the price of gasoline at all stations would probably lead to a much smaller percentage decrease in quantity demanded because there are fewer close substitutes available for gasoline. As a result, the demand for 'gasoline' ($Q(d)$) would be more inelastic than the demand for 'gasoline at Station k' ($Q(d)_k$).

There are ready parallels for this in postsecondary markets. If a small private college in the Midwest increased its tuition and fees by 25 %, we could expect a fairly large decrease in quantity demanded at the institution because many Midwestern college-bound students and their families would view other private institutions or one of the 4-year public colleges and universities in the state or region as being very close substitutes. However, if all 4-year institutions in the same region raise their tuition and fees by 25 %, the percentage decrease in quantity demanded would be much smaller because the only close substitutes would be area two-year community colleges and similar institutions of higher education outside of the geographic area. Accordingly, the demand for higher education at any one institution should be more elastic than the demand for higher education at all four-year colleges taken together.

There are other determinants of own-price elasticity of demand that are especially relevant to postsecondary markets. The price sensitivity of students may vary with their family income, in that students from lower-income families are more price responsive than their higher-income peers. This is to be expected because a year of college education—which is a fairly big-ticket item in any household's budget—is by definition an even "bigger" ticket item for lower-income households than it is for higher-income households.[15] Similarly, all else equal, first-generation

[15] A series of reviews of the research on students' own-price elasticity in higher education markets have consistently reported that lower- and lower-middle income students are more price sensitive than their higher-income peers (Heller, 1997; Jackson & Weathersby, 1975; Leslie & Brinkman, 1987; McPherson, 1978; Paulsen, 1998).

students and minority students—who are disproportionately overrepresented among lower-income families, and on average, have lower incomes than their peers—may be more sensitive to price changes (and thus have higher own-price elasticities) than their peers.

We may also find that the own-price elasticity of demand differs by type of institution. For example, it could be the case that the market demand for two-year community colleges is more price elastic than the market demand for 4-year public or private colleges.[16] This is not surprising because community colleges enroll disproportionately large numbers of students who come from lower-income families, and are first-generation college students, minority students, and nontraditional-aged students. At the same time, given that the cost of attendance at 2-year institutions is generally less than at 4-year institutions, the share of household budgets that the price of 2-year colleges accounts for may be lower, and markets for 2-year institutions have fewer suppliers, which may offset some of the effects of student characteristics on own-price elasticity of demand.

In addition to measuring own-price elasticity between two points along a demand curve, economists can talk about whether the entire demand curve is elastic or inelastic. This elasticity is represented graphically by the steepness of the demand curve. When the demand for postsecondary education is more inelastic to its price, the demand curve becomes steeper. Likewise, a relatively flat demand curve depicts a situation where demand is elastic, or more sensitive to price changes. This is shown in Fig. 5.20. The solid demand curve D_1 is relatively steep, indicating that the quantity of higher education demanded does not change very much when the price changes. This would be an example of an inelastic demand curve. Similarly, the second demand curve (D_2) represented by the dashed line is an elastic demand curve because changes in price lead to larger changes in quantity demanded. The own-price elasticity of demand may have important implications for the effects of changes in supply on equilibrium prices in the market. If the demand curve is very inelastic, then changes in supply will lead to larger changes in equilibrium price than would be true if the demand curve were more elastic.

Own-Price Elasticity of Supply

The concept of price elasticity can also be applied to the supply curve. In this instance, the *own-price elasticity of supply* ($E(P_k)_s$) represents the percentage change in quantity supplied due to a percentage change in the price of the good or service:

[16] Heller's (1997) review of research on own-price elasticity of demand reports greater price sensitivity among students at community colleges than their peers at other types of institutions.

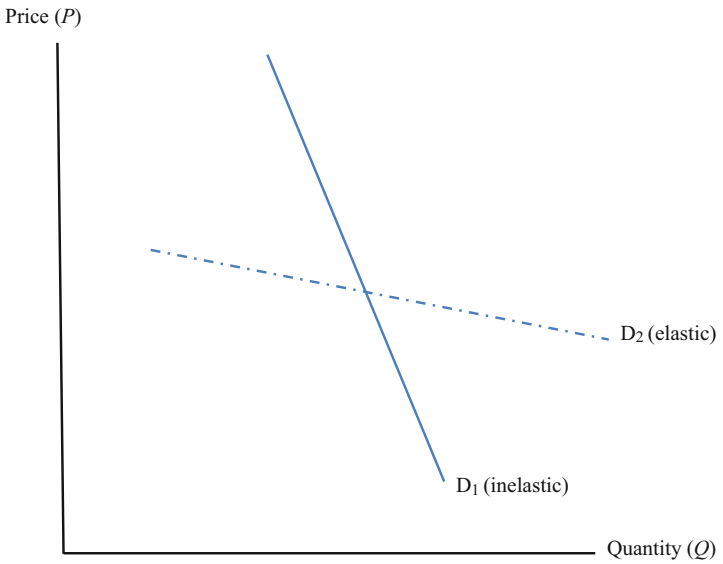

Fig. 5.20 Own price elasticity of market demand curves

$$E(P_k)_s = \frac{\%\Delta Q(s)_k}{\%\Delta P_k} \tag{5.12}$$

where $\%\Delta Q(s)_k$ denotes the percentage change in quantity supplied due to price. As with the formula for the own-price elasticity of demand, it is assumed that all other factors that could affect supply are held constant when calculating the own-price elasticity of supply.

Supply is said to be own-price elastic when a one-percent change in price leads to a more than one percent change in quantity supplied, indicating that supply is very sensitive to price changes. Likewise, supply is inelastic when a one-percent change in price leads to less than one percent change in quantity supplied, and is unit elastic when the percent change in supply is equal to the percent change in price. Because the supply curve is normally upward sloping, however, the own-price elasticities of supply are positive values in contrast to the negative own-price elasticities of demand.

The entire supply curve can also be described as being relatively elastic or inelastic, based on the relative steepness of the curve as shown in Fig. 5.21. The supply curve S_1, for example, is very steep, indicating that changes in price lead to only small changes in the quantity of higher education supplied by institutions. Accordingly, this would be an example of an inelastic supply curve and would apply to institutions that practice selective admissions. On the other hand, the second supply curve (S_2) is very flat, which denotes that price changes lead to large differences in the quantity of higher education supplied. Therefore, the second

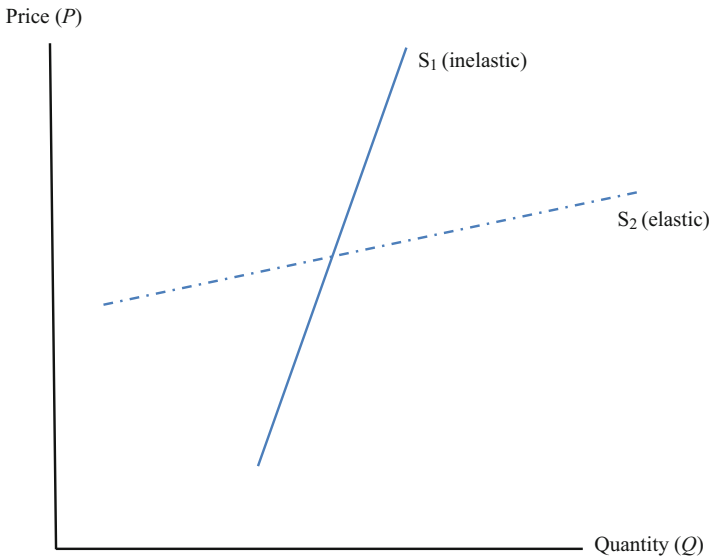

Fig. 5.21 Own price elasticity of market supply curves

supply curve is relatively elastic and corresponds to institutions that practice open admissions.

Cross-Price Elasticity of Demand

The notion of elasticity can be extended to virtually every factor that is part of the demand and supply functions for higher education. In these instances, elasticity measures the percentage shift in the demand or supply curve (as opposed to a movement along a demand or supply curve) due to a percentage change in a designated factor. For example, if the demand for higher education experienced only a very small shift when the consumptive benefits from going to college increase, then demand would be said to be relatively inelastic with regard to changes in consumptive benefits.

Economists focus most of their attention on two of the non-price elasticities as they pertain to the demand curve. The first of these is the *cross-price elasticity of demand*, which represents the percentage change in the demand for one postsecondary option due to a one percent change in the price of another option. In its most general form, the cross-price elasticity of demand is written as follows:

$$E(P_{k,l})_d = \frac{\%\Delta Q(d)_k}{\%\Delta P_l} \tag{5.13}$$

where $E(P_{k,l})_d$ = cross-price elasticity of demand for the k-th option due to a change in price for the l-th option, and $\Delta\%P_l$ = percent change in the price of the l-th option. The options in the formula can be individual institutions, such as k = University of New Hampshire and l = Plymouth State University, or groups of institutions such as k = 4-year public institutions and l = 4-year private institutions. It is assumed here that the price of the k-th option, family income, and all other demand curve shifters are held constant when calculating the cross-price elasticity of demand.

The cross-price elasticity of demand is used to determine whether two goods or services are substitutes or complements for each other. Two services are substitutes if consumers can use them in place of each other. Putting football rivalries aside, the University of Alabama (k) and Auburn University (l) are likely viewed as substitutes for each other by many students in the state of Alabama. The notion of substitutes can also be applied to groups of institutions, such as 2-year (k) versus 4-year (l) institutions, or in-state public (k) versus out-of-state public (l) institutions. If two goods or services are in fact substitutes, then as the price of one option increases, it should lead to increases in the demand for the other option. This translates into a positive value for the cross-price elasticity of demand. Furthermore, as the size of the cross-price elasticity of demand rises, the two services are said to be closer substitutes for each other. Accordingly, one might expect to find that Indiana University of Pennsylvania has a higher cross-price elasticity of demand with Clarion University of Pennsylvania than it does with Beijing Normal University in China because relatively few students are likely to include both Beijing Normal University and Indiana University of Pennsylvania in their choice sets.

It is also possible to measure the cross-price elasticity for complementary higher education services. Two services are referred to as complements for each other if they are often consumed at the same time. One clear example of complementarities in higher education is between instruction and non-instructional activities. Students pay tuition to cover instructional expenses, and usually incur additional mandatory fees for a variety of things such as student activities, health care, bus services, computing, and so on. In this sense, these extra services are consumed by students at the same time as their instruction. Room and board is another example of a complementary service to higher education instruction. When students go to college, they often have to also pay for (and thus "consume") living expenses. If two services are complements of each other, then an increase in the price of one service would lead to a decrease in the consumption of the other service because it is now more expensive to consume both services at the same time. An economist would therefore predict that increases in mandatory fees or in room-and-board charges would reduce the quantity of instructional services demanded by students, and vice-

versa.[17] As before, the larger the cross price elasticity of demand becomes, the stronger complements the two services are said to be for each other.

Income Elasticity of Demand

Finally, the last form of elasticity that is commonly addressed by economists is the *income elasticity of demand*. This represents the sensitivity of demand to changes in income:

$$E(I)_d = \frac{\%\Delta Q(d)}{\%\Delta I} \tag{5.14}$$

where $E(I)_d$ = income elasticity of demand, and $\%\Delta I$ = percent change in income, and as before it is assumed that all other factors that affect demand are held constant. Income elasticity of demand is important to economists for two main reasons. First, the ability to pay for goods and services, as reflected through income, is a factor in many models of consumer demand, including the demand for higher education. Second, government policies often involve income subsidies to lower-income individuals, and thus it would be useful for policy makers to know the magnitude of the effect of an income subsidy on consumers. The income subsidy can take different forms, including tax breaks that are given to families with children in college. The income elasticity of demand can in theory be positive or negative, depending on whether the good or service is a normal or an inferior good. If the good or service is a normal good, then the income elasticity of demand in Eq. (5.14) will be positive, and vice-versa when the good or service is an inferior good.

The concept of income elasticity of demand can be very informative for examining postsecondary markets. Consider the case of students who are attending 2-year (community) colleges. Typically, these institutions charge lower tuition than do 4-year institutions, and tend to attract more interest from students in lower-income families. If students at 2-year institutions were to experience an increase in income, however, they would be better able to afford to enroll at 4-year institutions and some may switch. At the same time, an increase in incomes for the general population may lead some students who previously could not afford to go to even a 2-year college to now be able to do so. For them, the increase in income leads to an increased demand for 2-year institutions. The net or average effect of an income increase would therefore represent whether 2-year institutions are thought of as a normal or inferior good in the higher education marketplace. In

[17] Alternatively, if an economist defines "price" as the full cost of attendance (tuition, fees, room and board), then an increase in room and board is a movement along the demand curve and not a shift in the demand curve.

contrast, institutions at the top end of the pricing distribution are most likely normal goods because an increase in incomes does not enable students to substitute towards more expensive options.

Issues in Measuring Elasticity

Although the concept of elasticity is relatively straightforward, in practice it can be very challenging to measure. There are two general approaches that economists use to measure elasticity, and each approach has its advantages and disadvantages. The first way to estimate elasticity is to calculate the percentage changes in the factors in question between two specific points in time. This may be done using the midpoint formula for the own-price elasticity of demand as follows:

$$E(P_k)_d = \frac{\left(\frac{Q(d)_2 - Q(d)_1}{\overline{Q}(d)}\right)}{\left(\frac{P_2 - P_1}{\overline{P}}\right)} \tag{5.15}$$

where $\overline{P}$ = midpoint of prices P_1 and P_2 at points 1 and 2, and $\overline{Q}$ = midpoint of quantities $Q(d)_1$ and $Q(d)_2$ at points 1 and 2.[18] Along any given demand curve, the own-price elasticity of demand could change depending on the shape of the curve and the points selected. While we focus on own-price elasticity of demand here, keep in mind that the same approach could be applied to the other three forms of elasticity covered in this chapter.

The main advantage of the midpoint formula for measuring elasticity is that it is easy to understand and calculate when given the appropriate numbers. To illustrate, suppose that points A ($P_A = \$8{,}000$, $Q(d)_A = 3{,}000$) and B ($P_B = \$10{,}000$, $Q(d)_B = 2{,}200$) represent two combinations of price and quantity demanded along the demand curve for a college. The own-price elasticity of demand using the midpoint formula would therefore be:

$$E(P_k)_d = \frac{\left(\frac{2{,}200 - 3{,}000}{2{,}600}\right)}{\left(\frac{\$10{,}000 - \$8{,}000}{\$9{,}000}\right)} = \frac{-0.308}{0.222} = -1.39 \tag{5.16}$$

In this example, as the price increased by 22.2 % there was a 30.8 % reduction in quantity demanded, and thus the demand curve is on average own-price elastic between these two points.

Although the midpoint formula appears to be relatively simple, in practice it can be very difficult to apply to postsecondary markets. The problem arises because

[18] The midpoint formula is useful for ensuring that the percentage change in quantity and price will be the same regardless of whether it is calculated moving from point 1 to 2 or from point 2 to 1.

demand and supply are affected not only by the price of the good or service in question, but also by a range of other demand and supply shifters. Recall that the definitions for elasticity assume that all factors other than the ones being examined are held constant. This assumption is more likely to be true in markets where prices change over short periods of time. In local markets for gasoline, for example, it would be hard to attribute any change in sales from one day to the next to a change in consumer incomes, preferences for gasoline, or population changes in the community. However, even in this example, competing stations may change their prices as well and have an influence on the station's sales. A relatively unique feature of postsecondary markets is that price of the service is usually held fixed for an entire year. The large amount of time between price changes increases the chance that other demand and supply factors may have also changed in the interim and affect the quantity demanded or supplied.

Let's use data for the University of Georgia as an illustration of the difficulty in measuring elasticity through the midpoint formula. Suppose that an economist wanted to calculate own price and income elasticities for the university between 2011 and 2012. The first two columns in Table 5.3 show statistics for these 2 years on the numbers of Georgia residents applying to, being accepted by, and enrolling at the University, the inflation-adjusted prices charged to resident students, and the per-capita incomes of Georgia residents. The third column contains the midpoints for each variable, and the fourth column shows the resulting percentage changes in each factor from 2011 to 2012.

Between 2011 and 2012, the price faced by students for attending the University of Georgia increased by only 0.4 %. During the same period, resident applications and enrollments moved in opposite directions, with applications rising by 3.9 % and enrollments falling by 11.8 %. As discussed in Chap. 3, however, neither applications nor enrollments are pure measures of demand because enrollments are affected by the supply decisions of the university, and applications may also be restricted to a lesser extent by supply due to concerns among students about their chances of being admitted. The price of attendance is likewise open to interpretation. The price shown here includes gross tuition, mandatory fees, room and board, and personal expenses. Arguments could be made for only focusing on tuition, or tuition plus mandatory fees, or tuition net of grants and scholarships as the appropriate measure of price. Finally, there are multiple ways of defining income for the purpose of calculating income elasticity. Incomes could be restricted to individuals who are in age groups that are most likely to attend college, or could be measured as per-capita income, median income, or household income for the state.

Putting aside for the moment these measurement questions, the resulting estimates of elasticity still may not be accurate. Using the midpoint formula, the own-price elasticity of demand (where demand = applications) from 2011 to 2012 for the University of Georgia is +10.7. The value suggests that a 1 % increase in price leads to more than a 10 % increase in applications. The elasticity estimate is puzzling because it is positive and thus does not conform to the law of demand, and demand appears to be extremely sensitive to price. On the other hand, if enrollments were instead used to measure demand, the same price change is associated with a

Table 5.3 Illustration of elasticity calculations for the University of Georgia, 2011 to 2012

Factor	2011	2012	Midpoint	% change from 2011 to 2012
Applications	11,952	12,428	12,190	+3.9 %
Acceptances	7,989	7,282	7,636	−9.3 %
Enrollments	4,876	4,332	4,604	−11.8 %
Resident price	$21,172	$21,250	$21,211	+0.4 %
Income	$24,097	$24,321	$24,209	+0.9 %
	If Demand is Represented by:			
Elasticities	**Applications**	**Enrollments**		
Own price demand =	+10.7	−32.3		
Income =	+2.5	−0.1		

Notes: Data on cost of attendance, applications, acceptances, and enrollments for Georgia residents were supplied by the Office of Institutional Research, University of Georgia. Data on per-capital income were obtained from the Census Bureau. Both the resident price and per-capital income are expressed in inflation-adjusted 2012 dollars. Resident price includes tuition, mandatory fees, room and board, and personal expenses

large decrease in enrollments (elasticity = −32.3). A strict interpretation of this value would conclude that demand is highly own-price elastic.

Neither estimate, however, is an accurate measure of the own-price elasticity of demand because the change in applications and enrollments between 2011 and 2012 could have been affected by a number of factors in addition to price. For example, the University of Georgia reduced the number of acceptances by 9.3 % between 2011 and 2012, and thus the drop in enrollments reflects the supply decisions of the institution as well as demand decisions of students. Any number of other things could have also changed between 2011 and 2012 that may have shifted the demand curve and thus affect applications as well, such as the incomes of students and their families, the prices of other institutions, financial aid offers, application fees, and non-financial attributes of the institution. The same problem occurs when calculating the income elasticity of demand. The estimated income elasticity of demand shown in Table 5.3 suggests that the University of Georgia is a normal good when applications are used and neither a normal nor inferior good when enrollments are used to represent demand. Yet we know from the data in the table that the University of Georgia's price changed over this time period, and other demand factors aside from income could have changed as well.

To avoid some of the problems with the midpoint method, another approach to measuring elasticity is to estimate the demand equation with a multiple regression model. The demand equation for the k-th postsecondary option may be written in general form as follows:

$$lnQ(d)_k = \alpha + \beta_k lnP_k + \beta_l lnP_l + \gamma lnI + \boldsymbol{X\delta} + \varepsilon \tag{5.17}$$

where ln = natural log transformation, P_k = price of k-th institution, P_l = price of l-th institution, I = family income or wealth, and $\boldsymbol{X}$ = set of other factors that may shift demand. The advantage of using this special functional form (known as the "double log" specification) is that the coefficients for the variables P_k, I, and P_l are interpreted as elasticities. For example, the coefficient β_k shows the percentage change in the demand for postsecondary option k due to a one percent change in the price of the k-th option, holding all other variables in the equation constant. Likewise, the coefficients β_l and γ show the percentage changes in the demand for postsecondary option k due to a one-percent change in the price of the l-th institution or a one-percent change in family income or wealth, respectively, holding all other variables in the equation constant. The double-log demand curve is appealing to researchers because it has the same elasticity at any point along the curve. Of course, if the true functional form for the demand curve is not a double-log function, then the elasticity measures will be incorrect.

The early demand studies in economics mainly focused on forecasting changes in demand for postsecondary education, and thus used time-series data. With time-series data, the researcher can observe whether changes in tuition and fees are correlated with changes in the share of population going to college:

$$\ln\left(\frac{Q(d)_t}{POP_t}\right) = \alpha_0 + \alpha_1 \ln P_t + \gamma \ln I_t + \ln \mathbf{X_t}\boldsymbol{\delta} + \varepsilon_t \tag{5.18}$$

where $Q(d)_t / POP_t$ = share of the designated population enrolling in year t, P = tuition and fees, I = income or ability to pay for college, and $\boldsymbol{X}$ = set of other characteristics that may affect demand for college and change over time, such as the unemployment rate and the characteristics of the student population. The demand equation can be estimated for all institutions combined or for designated groups such as all 4-year public institutions.

Among the first studies of demand for postsecondary education of this type was conducted by Campbell and Siegel (1967). They used this approach (in double-log form) to determine how disposable income and tuition affected the proportion of high school graduates ages 18–24 enrolling in college in selected years from 1927 to 1963. They found that demand was own-price inelastic ($E(P_k)_{\mathrm{d}} = -0.44$) and that postsecondary education was a normal good ($E(I) = 1.20$).

Despite its advantages, there are still several challenges that have to be addressed when trying to estimate the demand Eq. in (5.18). To determine how changes in prices, incomes, and other factors affect demand and supply, data must be obtained over multiple time periods. Since these factors are generally held constant for an entire year and these variables are rarely tracked prior to the 1970s, it would be difficult to find enough data to reliably estimate the demand equation using time-series data. In fact, the regression model reported in the 1967 study by Campbell and Siegel relied on only nine observations.

In a cross-sectional study, data are used on individual students or groups of students to examine how prices and other factors influence their postsecondary choices. The demand equation for groups of students might be written as:

$$ln\left(Q(d)_k/POP\right) = \alpha_0 + \alpha_1 lnP_k + \boldsymbol{lnP\beta} + \gamma lnI_k + \boldsymbol{X\delta} + \varepsilon_k \tag{5.19}$$

where $Q(d)_k$ / POP = share of the designated population enrolling in the k-th institution, and $\boldsymbol{P}$ = vector of prices at all institutions that compete with the k-th institution for students. The main challenge with this approach is that the prices would be the same for all students in the market. In this instance, the researcher can try to find other variables that are related to price but vary across students. Hoenack (1967), for example, used the distance from a student's home to the institution in question as a measure of price, asserting that as distance increases the cost of attendance will also increase. Spies (1973) and others used another approach in cross-sectional studies by replacing price in Eq. (5.19) with a variable for price as a share of income ($\boldsymbol{P/I}$). The argument made by Spies is that dividing by income introduces variability in the price variable and reflects the "price" to the individual student for attending the institution.

The demand equation could likewise be estimated using data on individual students at one point in time. The dependent variable in this type of study is a dichotomous choice variable representing whether or not a student considered/applied/enrolled at the institution. The advantage in estimating a cross-sectional model is that the economist can greatly increase the sample size needed for statistical purposes. Students and their families will vary in terms of their incomes, enabling the analyst to measure the income elasticity of demand. However, at any one point in time the price of the k-th postsecondary option will be the same for all students. This presents a problem because there is no variation in the price of the service, and variation is needed to find the own-price elasticity of demand. One way to address this problem is to replace the price variable with a variable for the amount of financial aid received, as in:

$$q(d)_{jk} = \alpha_0 + \alpha_1 F_{jk} + \gamma I_j + \boldsymbol{X_j\delta} + \varepsilon_j \tag{5.20}$$

where $q(d)_{jk}$ = individual demand for the k-th institution, and F_{jk} = amount of financial aid offered to the j-th student by the k-th institution. Because financial aid reduces the net price paid by students, the coefficient α_1 represents the sensitivity of demand to price (and $\alpha_1 > 0$ indicates that the demand curve is downward-sloping).

The challenges of inadequate variation in price and insufficient observations for meaningful estimation can be addressed by combining time-series data on price and enrollment demand for multiple institutions. This can be done by creating a panel dataset characterized by both year-to-year variation and college-to-college variation in price and enrollment demanded, while controlling for the effects of other relevant variables. For example, Paulsen and Pogue (1988) used a fixed effects,

covariance model to estimate a market demand equation by pooling data on 64 small private 4-year colleges (in Iowa and Illinois) over a 16-year period. Using a double-log specification and controlling for other relevant factors, they found that the own-price elasticity of demand for this group of institutions was −0.17.

Extensions

Alternative Measures of Demand

There have been numerous studies on the demand for postsecondary education. These studies vary in terms of how they measure demand, supply, and prices. While the majority of economic studies have used enrollments as a measure of demand, this can be problematic because the enrollment decision is affected by both the demand from students and the supply from institutions (see Chap. 3). In some instances, however, enrollment figures can be reasonably interpreted as demand. If the institution being examined is an open-admission institution, then any change in enrollments by definition is due to changes in demand and not supply. Or if the postsecondary option being examined is at an aggregate level (such as enrollments in any college or in 4-year colleges), then changes in enrollments most likely are due to changes in demand and not supply because most students with a predisposition to college could find some place to enroll. On the other hand, if an institution has a fixed supply of spaces and more applicants than they can accommodate, then changes in enrollments for this institution most often reflect changes in supply and not demand.

Some researchers have turned to alternative measures of demand to avoid the identification and interpretation problem with enrollments. These studies try to find measures that correspond with the third stage of the student choice model in Chap. 3, where students form their initial demands for attending an institution. The dependent variables in these studies may represent the number of applications received by an institution.[19] Researchers have also used the number of students having their SAT or ACT scores sent to an institution as an indicator of whether a student included a college in his or her choice set.[20] Depending on data availability, researchers could use other measures of early interest as well, such as campus visits, requests for information, or application for financial aid. The advantage of using these measures is that they are not as affected as other measures of demand by the number of spaces made available by an institution.

[19] See, for example, studies by Savoca (1990), DesJardins, Dundar, and Hendel (1999), and DesJardins, Ahlburg, and McCall (2006).

[20] See, for example, studies by Toutkoushian (2001a, 2001b). Note that these studies correspond to the second stage of the college choice model in Chap. 2.

Quasi-Experimental Methods

As we have noted, there are limitations with the demand models that we have described in this chapter that make it difficult for researchers to obtain good estimates of price and income elasticities. In large part, the limitations are due to the fact that economists must rely on observational data rather than construct experiments. In an environment where prices, incomes, and financial aid can all change at the same time, economists cannot easily hold all else constant and thus the demand measures on the left-hand side of the equation are potentially affected by many different factors.

Another problem in empirical work on this topic is that in most instances the receipt and level of financial aid is not an exogenous variable. Financial aid is not awarded at random; instead, aid is given to students on the basis of financial need, academic merit, and other criteria. The effect of financial aid on demand is further complicated by the fact that in order to receive financial aid, students must seek it out. It is likely that those students who were active in looking for aid are somehow different from other students. In particular, if students who were more determined to succeed and go to college were more likely than others to receive financial aid, then the estimated effect of receiving aid in equations such as (5.20) could in fact reflect these other factors and not the aid itself.

Economists have tried to address these difficult issues by using an array of methods known generally as "quasi-experimental methods." These methods include such techniques as regression discontinuity, two-stage least squares, difference-in-difference, and natural experiments.[21] The goal of these types of studies is to reduce the potential bias from self-selection and unobservable factors on the estimated impact of selected variables on postsecondary demand. The specific quasi-experimental approach that economists use in this research depends on the problem at hand and the type of data that are available.

In a regression discontinuity approach, the goal is to determine if the demand for postsecondary education is the same for students who face different prices but otherwise have very similar characteristics. This method can be used for financial aid programs when the award is based on a quantifiable factor such as family income. For example, the federal Pell Grant is awarded to students who are eligible for free lunch, which is determined through family income. A regression discontinuity study of the Pell Grant program might then compare the demand for postsecondary education for students with family incomes within ± $5,000 of the cutoff for free lunch eligibility. The same approach could be applied to merit-based

[21] It is well beyond the scope of this book to provide details on the different quasi-experimental techniques that economists have used to examine issues in postsecondary education and related topics. We highly recommend the book *Methods Matter* by Murnane and Willett (2011) for an overview of these techniques, as well as studies by Thistlethwaite and Campbell (1960), Lee and Lemieux (2010), Imbens and Angrist (1994), McCall and Bielby (2012), Reynolds and DesJardins (2009).

aid programs when the award is determined by criteria such as a student's grade point average in high school or SAT score.

Another quasi-experimental method that has been used in postsecondary research is known as two-stage least squares (or instrumental variables). This technique attempts to reduce the bias in the effect of financial aid due to unobservable factors by finding one or more factors (called "instrumental variables") that help predict receipt of financial aid but do not directly affect the demand for postsecondary education. The equation predicting whether a student receives aid is then estimated simultaneously with the demand equation, and provided that certain conditions are met, the resulting estimates of the effect of aid on demand will be unbiased.[22] Despite the fact that two-stage least squares has been used in countless studies of education, in practice the conditions for unbiasedness can be hard to satisfy. The economist must convince the reader that there is at least one variable that can predict receipt of financial aid and yet not have a direct effect on the demand for postsecondary education. Unfortunately, most of the variables that might be considered as good predictors of financial aid—such as family income and academic performance—would also be thought of as demand curve shifters, and thus would not be good instrumental variables.

Other quasi-experimental approaches fall under the heading of what are called "natural experiments." This phrase relates to situations where an entity imposes a policy that leads to a change in price or financial aid that was not anticipated by most students and their families. The economist can then compare the demand for postsecondary education prior to and following the policy change to see if the resulting change in price or aid had an effect on student behavior. These types of studies are particularly useful for federal or state financial aid programs where the government makes changes in the amount of the award or the criteria for receiving the award.

Policy Focus

In this section on higher education policy, we show how demand, supply, and comparative statics can be used to analyze two different policy applications to higher education: (1) the growth in state broad-based merit aid programs, and (2) the rise of the private for-profit sector in higher education.

[22] See Imbens and Angrist (1994) for an excellent discussion of the conditions needed to apply the instrumental variable technique.

State Broad-Based Merit Aid

Prior to 1993, state financial support for postsecondary education was primarily in the form of appropriations to designated institutions and need-based financial aid to students. Although some states gave additional funding to students in recognition of their academic performance, the number of students benefiting from this merit aid was small. In 1993, however, the state of Georgia introduced the first large scale—or broad-based—merit aid program known as the HOPE ("Helping Outstanding Pupils Educationally") scholarship. The HOPE scholarship was intended to provide financial assistance for college to large numbers of students who met the award criteria, which in Georgia was to have a high school GPA of 3.00 or higher. By 2010, approximately one-third of all states in the United States had implemented similar broad-based merit-aid grant programs (Dynarski, 2004; Toutkoushian & Hillman, 2012).

Broad-based merit aid programs provide state grants to students that in turn would reduce the net price that they pay for attending specific colleges. The amounts of the grants ranged from full tuition at public four-year in-state institutions down to smaller amounts often expressed as either a designated dollar amount or a specific percentage of the public four-year tuition. The intent of these programs is to provide a financial incentive for students to perform better in high school and college, and to stay in their state of residence for their postsecondary education and hence reduce concerns about "brain drain" to other states.

Figure 5.22 illustrates how the introduction of a broad-based state merit-grant program would be predicted to affect the overall market for higher education. Point A represents the initial market equilibrium. It corresponds to the point where the initial demand curve (D_1) intersects the supply curve (S) at tuition price P_1 and a quantity enrolled of Q_1. The introduction of a broad-based grant program would lead to an increase in demand for higher education among students from the state. The vertical distance between the old (D_1) and new (D_2) demand curves represents the size of the grant to each student. The increase in demand is represented by an upward shift. The new market equilibrium is represented by point B, which indicates the point where the new demand curve (D_2) intersects the initial (and unchanged) supply curve (S). All else equal, this results in a higher quantity of student enrollment Q_2 and higher tuition price P_2. This is the outcome of a process that increases subsidies to student consumers in the higher education market of interest. As a result, the merit aid program should lead to increased enrollments in higher education.

The merit aid program would also be predicted to have interesting effects on specific institutions. In particular, some institutions may benefit more than others from the broad-based merit aid program. For a student to receive a state broad-based merit aid award, he or she is must attend an institution that is designated by the granting state. Usually, states require grant recipients to enroll at an in-state public institution, or a public/private institution located within the state boundaries. Accordingly, the shift in the demand curve for an in-state institution would reflect a

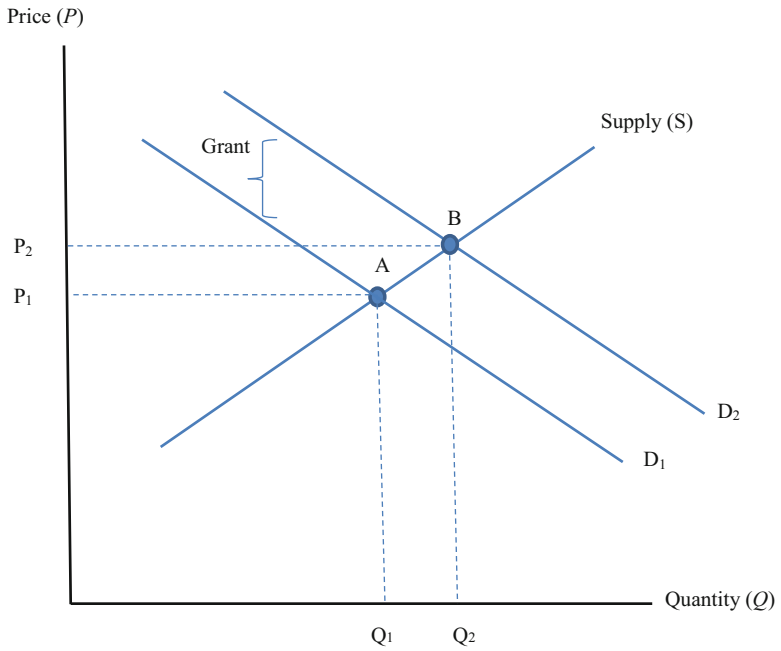

Fig. 5.22 Effect of state broad-based grant on overall postsecondary education market

larger benefit from the merit aid grant because students are overall more likely to go to college, and the price of an in-state college has become substantially lower relative to out-of-state options. The situation is quite different for an institution where the grant cannot be used, such as an out-of-state institution. In this case, the state grant represents a price decrease for one or more of the out-of-state institution's competitors, which would cause the out-of-state institution's demand curve to decrease.

Growth of For-Profit Higher Education Sector

One of the more remarkable trends in the postsecondary education industry in recent years has been the significant growth in the private for-profit sector. Table 5.4 shows how the number of postsecondary institutions by sector in the United States has changed from the 1970s through 2012. In the 1970s, virtually all private institutions were not-for-profit in nature. Although the number of private not-for-profit institutions has remained fairly steady over the next 40 years, for-profit institutions grew from 55 in 1976 to 1,451 by 2012.

Such a substantial increase in the number of private for-profit institutions in the United States raises interesting questions about how the growth will impact

Table 5.4 Number of postsecondary education providers by sector, 1976 to 2012

Year	Public	Private Not-for-profit	Private For-profit	Private for-profit share of total (%)
1976–1977	1,455	1,536	55	1.8
1986–1987	1,533	1,635	238	7.0
1996–1997	1,702	1,693	614	15.3
2006–2007	1,688	1,640	986	22.9
2012–2013	1,623	1,652	1,451	30.7

Source: Digest of Education Statistics 2013, Table 317. Data include 2-year and 4-year institutions and their branch campuses

postsecondary education markets. Economists would argue that this represents an increase in the number of suppliers in markets. This change would cause the market supply curve to shift to the right, which should put downward pressure on prices and increase the number of students who can receive postsecondary services.

Curiously, the 40-year period where the market supply curve shifted to the right was also marked by tuition increases that generally outpaced inflation. What happened? One possible explanation is that there were other demand factors (e.g., increasing earnings of college graduates, increasing financial aid to students) and supply factors (e.g., reduced state appropriations, rising prices of resources such as administrators, staff, and faculty) that also changed during this period that put upward pressure on market prices. In other words, the ceteris paribus assumption likely does not hold in this case, and the price changes cannot be solely attributed to the growth in the for-profit sector.

Another possible explanation is that the growth in the for-profit sector had different effects across the various postsecondary markets. Most of the for-profit providers do not offer graduate degrees, and thus the shift in the supply curve for graduate markets has been relatively small. Likewise, for-profit institutions operate mainly in markets for older and non-traditional students, and thus the growth did not have a substantial effect on the prices and enrollment decisions of traditional-aged students. Taken together, it is not surprising that the substantial increase in the for-profit sector has not led to lower prices for postsecondary education.

Final Thoughts

In this chapter, we focused on how the economic concepts of demand, supply, elasticity, and markets can be applied to postsecondary education. The demand curve is the result of the decisions made by individuals who must allocate their time and income constraint among competing uses, typically education and all other goods and services. Demand is posited to be affected by the utility from the net benefits (both market and non-market) of going to college, students' ability to pay, and personal characteristics that may shape preferences. The supply side is driven

by the opportunities available to suppliers (colleges and universities), the cost of doing business, and the goals/objectives of the supplier.

The own-price elasticity of demand is defined as the percentage change in quantity demanded divided by the percentage change in price. The share of the budget that higher education accounts for is often quite substantial. As a result, students from lower-income families tend to be more sensitive to price changes than their higher-income counterparts. Because students who are first-generation, underrepresented-minority, part-time, and non-traditional-aged are disproportionately overrepresented among lower-income students, they are also, on average, more price sensitive.

It is important to define the market of interest before beginning a study of supply and demand. Equilibria in postsecondary markets are moving targets, in that the market demand and supply curves are in constant flux due to changes in various forces in the marketplace. In this sense, demanders and suppliers in each postsecondary market can be thought of as moving towards a new equilibrium, rather than resting at a final equilibrium price and quantity as depicted in a typical supply/demand graph.

Glossary

Symbol	Definition
I	Income
P_{ED}	Price per unit of higher education
ED	Number of units of higher education consumed
ED^*	Utility-maximizing number of units of higher education consumed
P_{OG}	Price per unit of composite 'all other goods'
OG	Number of units of composite 'all other goods' consumed
$U()$	Utility function or indifference curve
$f()$	Function symbol
MRS	Marginal rate of substitution
MU	Marginal utility
Δ	Change symbol ("delta")
L	Lagrangian function
$\tau(tau)$	Shadow price of income in Lagrangian function
$\boldsymbol{a}^*_{jk}$	Latent demand for considering the k-th institution
P_k	Price of the k-th institution
|	Conditional symbol
$\boldsymbol{a}^*_j$	Latent demand for considering college
$\boldsymbol{q}(\boldsymbol{d})^*_{jk}$	Latent demand for applying to the k-th institution
$Q(d)_k$	Number of students who apply to the k-th institution
$Q(s)_k$	Number of spaces supplied by the k-th institution
R_k	Price of resources needed by the k-th institution to supply services

(continued)

Symbol	Definition
H_k	State of technology for k-th institution for supplying services
G_k	Subsidies to the k-th institution from government and other sources
$Q(d)$	Market demand
$Q(s)$	Market supply
D	Demand curve
S	Supply curve
$\boldsymbol{E(P_k)_d}$	Own-price elasticity of demand
$\boldsymbol{\%\Delta Q(d)_k}$	Percentage change in quantity demanded
$\%\Delta P_k$	Percentage change in price of k-th institution
$\boldsymbol{E(P_k)_s}$	Own-price elasticity of supply
$\boldsymbol{\%\Delta Q(s)_k}$	Percentage change in quantity supplied
$\boldsymbol{E(P_{k,l})_d}$	Cross price elasticity of demand
$E(I)_d$	Income elasticity of demand
$\%\Delta I$	Percentage change in income
$\boldsymbol{\overline{P}}$	Midpoint of prices for elasticity formula
$\boldsymbol{\overline{Q}(d)}$	Midpoint of quantity demanded for elasticity formula
$\boldsymbol{\overline{Q}(s)}$	Midpoint of quantity supplied for elasticity formula
$Ln(\ )$	Natural log function
β_k	Coefficient estimating own-price elasticity of demand
β_l	Coefficient estimating cross-price elasticity of demand
γ	Coefficient estimating income elasticity of demand

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