Basic Economic Concepts

"The quality of a nation's infrastructure is a critical index of its economic vitality. Reliable transportation, clean water, and safe disposal of wastes are basic elements of a civilized society and a productive economy. Their absence or failure introduces an intolerable dimension of risk and hardship to everyday life, and a major obstacle to growth and competitiveness."[1]

Introduction

This essay introduces various economic concepts that are useful in understanding infrastructure systems and in identifying and evaluating potential projects for improving their performance. The chapter begins with a discussion of how **equilibrium prices** result from the interaction of **supply and demand**. If prices are high, say for office space or for energy, then a great deal of investment in new buildings or oil drilling or wind power is justifiable. If too many buildings are built or if too much oil is available on the world market, then prices fall and investments based upon continuing high prices may well fail. The success or failure of any major project will depend in part upon the future interactions between supply and demand.

Costs, prices, and values are distinct concepts that should not be confused. The cost of providing a service or of manufacturing a product depends upon such things as resource requirements, capacity requirements, and unit costs associated with operations. While owners surely desire that prices be higher than costs, prices are usually determined by market forces that may have little or no relationship to cost. The value of a product or a service is something that can only be determined by potential purchasers: if they perceive the value of a product or service to be higher than the price, then they will go ahead and make the purchase. The difference between what they were willing to pay and what they actually paid is an economic benefit known as **consumer surplus**, which is in fact an economic benefit even though it does not result in any revenue to the supplier. Large infrastructure projects are often justified in part by increases in consumer surplus, so this is an important concept for evaluating such projects.

From an economic perspective, a major goal of any project will be to increase **productivity**, which is defined as the ratio of system output to system input. If productivity improves, then more output can be obtained using the same or fewer resources, resulting in an overall benefit for society. If a company is able to produce more without increasing its labor force, then it may be able to afford to pay higher wages to its employees. Companies and agencies that manage infrastructure will continually be seeking ways to make more productive uses of their resources, and productivity improvement motivates many infrastructure projects and programs. In most infrastructure systems, there are **economies of scale, scope or density** that allow larger, more complex systems to offer more benefits at a lower cost.

Lower cost would seem to be a clear benefit to society, but project evaluation must consider who will capture the benefits of lower cost, the supplier or the customers? The answer to this question depends upon the extent of competition. If there are many potential suppliers, then there will be competition for customers, and prices will fall to marginal costs (**marginal cost pricing**) and customers will benefit from any productivity improvements. However, if a single supplier has no competition or very limited competition, then it will be able to charge prices that are well above marginal costs. The threat of **monopoly pricing** is therefore present whenever there are strong economies of scale. To achieve public benefits from scale economies related to essential infrastructure, it may be necessary to have public ownership or some sort of **price regulation**.

There are multiple reasons why infrastructure performance and major infrastructure projects will always be of interest to the public:

---

[1] National Council on Public Works Improvement, **Fragile Foundations: a Report on America's Public Works**, Final Report to the President and Congress, February 1988, p. 1

- First, the public uses the infrastructure, and the performance of the infrastructure affects everyone's daily life.
- Second, much of the public infrastructure is owned or regulated by public agencies, so that there is a direct public interest in managing and investing in that infrastructure.
- Third, infrastructure projects are large projects with long-lasting impacts on society and the environment, and the public has a justifiable interest in questioning whether these impacts are positive or negative and whether the costs and benefits of a major project are equitably shared.
- Fourth, investment in infrastructure projects can provide a boost to the region in terms of jobs, income, and economic growth through what is called the **multiplier effect**.

Infrastructure needs depend in part upon the economic forces that drive regional, national, and international development. Where goods are produced depends in part upon where raw materials can be found, where it is most efficient to produce the goods, where labor and other resources are cheapest, and the cost of transportation. As transportation costs decline, because of improvements in technology and expansions of transportation infrastructure, distance ceases to be an impediment to consolidation of agriculture, manufacturing, mining, and other industrial activities. Cheap transportation has enabled the rise of a global economy, and regions in one country now compete with regions in other countries for all sorts of economic activities. Two concepts that are directly relevant to understanding the global economy are **spatial price equilibrium** and **comparative advantage.** As patterns of trade and production shift, the needs for industrial facilities and transportation infrastructure also shift. In the less developed parts of the world, investments in infrastructure may be required for the economic growth. In the developed parts of the world, existing infrastructure that was designed for the economy of the 19th or 20th centuries may need to be redeveloped or replaced by infrastructure relevant to the 21st, with greater emphasis on major ports and continental distribution systems and less emphasis on access to local production facilities.

Project evaluation requires consideration of broad economic issues such as globalization, the need for regulatory policy, corporate decision-making, and the importance of regional economic impacts. However, it is also worth considering the perspective of the individuals who ultimately will be making the decisions that determine which types of infrastructure are used, how much revenue is gained, and whether or not infrastructure projects prove to be successful. Individuals decide such things as how much living space they need, whether to live in the city or a suburb, whether or not to water the lawn on a regular basis, whether to drive or take the bus to work, whether to switch from oil to natural gas for home heating, and where to go on vacation. The concept of **utility** provides a framework that can be used to understand how these decisions are made. The basic idea is that individuals are assumed to make decisions that maximize their utility based upon personal constraints related to time and money.

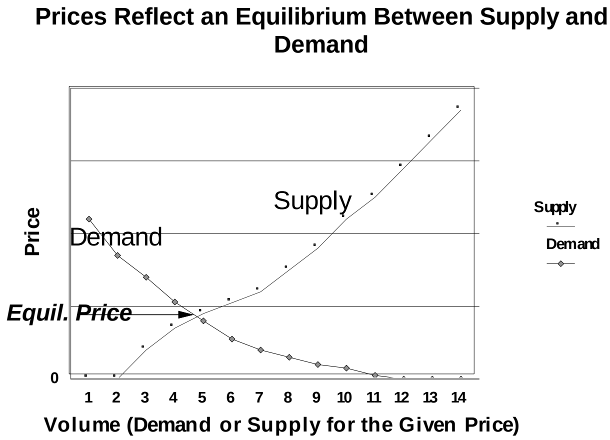
Supply, Demand, Equilibrium

Overview

Supply, demand, and equilibrium are central issues in economics. At the most basic level, both supply and demand are described as functions of price, and the **equilibrium price** is the price at which supply equals demand. The **supply function** shows the quantity of goods or services that will be produced for each price. Under normal circumstances, the supply of goods and services would be expected to increase as the price increases. If the price is higher, then existing suppliers will be willing to produce more, and new suppliers may be enticed to enter the market. The **demand function** shows the quantity of goods or services that will be purchased for each price. Under normal circumstances, the demand will decline as the price increases. Some people may be willing to pay a high price, but more people will be willing to pay when the price is lowered.

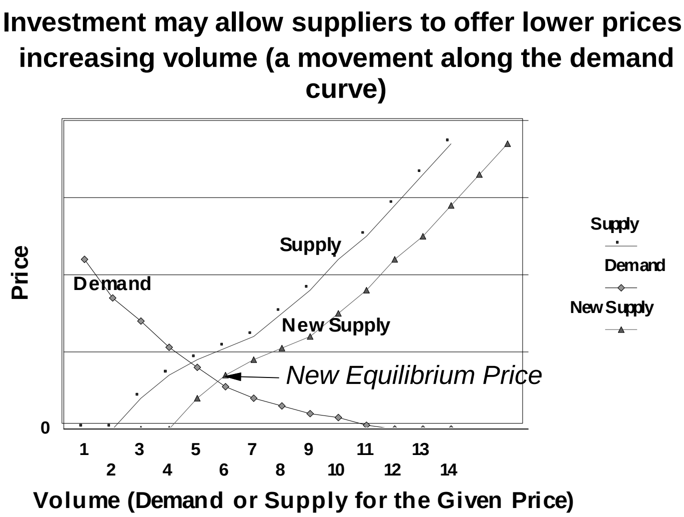
The interaction between supply and demand can conveniently be expressed in a chart as portrayed in Figure 1. Note the convention that price is shown on the y-axis, although that is assumed to be the independent variable, while the volume or quantity of supply and demand are shown on the x-axis. The point at which the supply and demand functions intersect is the equilibrium price. What is most important to understand is that this equilibrium price reflects both supply and demand: under competitive market conditions, prices will adjust to changes in supply and demand, and there will be a tendency for

Price



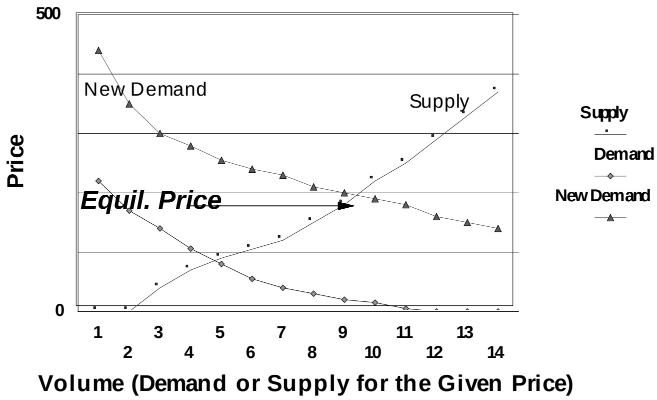
Over time, factors that affect both supply and demand are subject to change. First consider changes in supply. Investing in new technologies or in more efficient production facilities or simply adopting better management techniques may make it possible for suppliers to offer greater quantities for any given price. Graphically, this results in a shift in the supply curve to the right and leads to a new – lower – equilibrium price, as shown in Figure 2. Note that the demand curve has not changed at all: with the lower prices, people are willing to buy more, which is what is described by the demand curve.

offer
equilib



The demand curve may also change (Figure 3). For example, growth in population or increases in family income may result in an increase in cars purchased, attendance at movie theatres, or use of air transportation. These changes appear on the graph as an upward shift in the demand curve: at each price level, a greater quantity of goods and services is purchased or used.

Population Growth, Advertising, Higher Incomes, or other Factors May Cause an Increase in Demand (a shift in the demand curve)



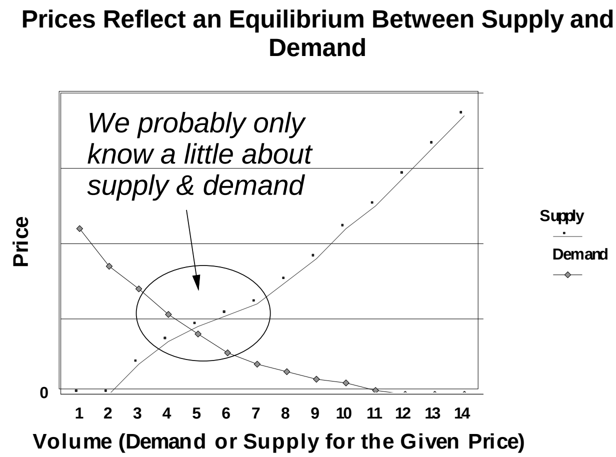
If demand increases, then prices will rise; if demand declines, then prices will fall. How much prices rise or fall will depend upon the shapes of the supply and demand curves. How quickly prices rise or fall will also depend upon the nature of the goods and services being sold. Outside a sold-out baseball stadium, the prices that scalpers charge for tickets will react within minutes to changes in demand. Achieving an equilibrium in the prices of new homes is something that may take years, as evidenced by the steady decline in home prices that began in 2007 and continued for several years thereafter because of what has been called "The Great Recession." Adjusting transportation networks to changes in oil prices or new technologies is a process that takes decades – and may never reach equilibrium, because only a small portion of the transportation network can ever be changed within just a few years.

In many circumstances, changes in demand result not in a change in price, but in poor service, congestion or long lines as too many people try to buy something or to use something at the same time. The time spent in line can be viewed as part of the price of the service that is being sold: some people will come with an intent to buy, but depart as soon as they see the line.

Over time, suppliers will react to changes in demand by adjusting their levels of production. New companies may emerge in response to increases in demand; companies may go out of business in response to decreases in demand.

It is possible to spend a lot of time trying to understand the supply and demand curves, and there are some ingenious methods for estimating these curves based upon past experience. However, it is important to retain some humility, for we probably only know a little about how supply and demand vary within a fairly small range of prices and existing conditions (Figure 4). When new projects are being considered, it is possible that the quantity or quality of services provided will be far different than what is currently available. Special studies can be undertaken to try to estimate the effects of the new projects on demand, but such studies will never be exact.

Figure 4 The int
if the fac



rstood, especially
long time

<u>Consumer Surplus</u>

Given the shape of the demand curve, it is clear that the equilibrium price is lower than the price that many would be willing to pay. The difference between what someone is willing to pay and the equilibrium price is called **consumer surplus**. For each individual:

(Eq. 1) Consumer Surplus = (Willingness-to-pay) – (Equilibrium Price)

Consumer surplus is greatest for those willing to pay the highest prices. For someone willing to pay only the actual price and not a penny more, the consumer surplus is zero. The total consumer surplus in principle could be obtained by summing the surpluses for everyone using a product or service. In practice, this is infeasible, as data is collected and decisions are made based upon actual prices. Unless special studies are undertaken, little is known about how much more people would be willing to pay for things that they now buy or for services that they now use. For this reason, it is easier to focus on the changes in consumer surplus that may result from changes in equilibrium prices.

Consider the change in supply illustrated above in Figure 2. The shift in the supply curve increased consumer surplus by a) lowering the price for those who previously were willing to pay a higher price and b) allowing more people to purchase the product. The increase in consumer surplus can be estimated just by looking at prices and volumes before and after the change in supply:

(Eq. 2) Increase in Consumer Surplus = $V_0 (P_0 – P_1) + ½ (V_1 – V_0) (P_0 – P_1)$

The first term in this equation is the benefit to existing users from the reduction in price, while the second term represents the benefits gained by new users. The full decline in price is not a benefit for new users, since they were unwilling to pay the old price. If the relevant portion of the demand curve is assumed to be a straight line, then the consumer surplus for the new users will be the area of a triangle whose base B is the difference in volume and whose height H is the difference in price, and whose area is ½ BH. In effect, this assumption – sometimes called the **"rule of ½"** - provides a simple way to estimate the area under the demand curve without needing to estimate an equation for that curve.

Note that consumer surplus is an economic rather than a financial concept. Price is a financial measure, as is manufacturing cost; these are things that can be measured in dollars and cents and these are things that can and will be recorded in check books and accounting systems. Consumer surplus is not related to any such accounting, but it is still an important matter for evaluating the economic impact of projects. There is a public benefit resulting from projects that increase consumer surplus, because people will still have the money that they otherwise would have been willing to pay for the product or the service. They can save that money or use it to buy something else. Either way, there is a benefit for the individuals and for the local economy. Thus, change in consumer surplus, though not a direct concern for the private sector or for investors, is an important consideration in evaluating the public economic impacts of proposed infrastructure projects.

Elasticity of Demand

It is possible, but difficult, to obtain the detailed information needed to plot supply and demand, so a more abstract approach is often used. Consultants or marketing managers may use past experience in trying to answers questions such as "How much will demand change for a given change in price?" or "Will total revenue go up, down, or stay the same if the price is changed?"

These questions can be answered by using the concept of **elasticity of demand**, which is a measure of how sensitive demand is to changes in price. Elasticity of demand is defined as the negative of the derivative of the quantity demanded Q with respect to price P.

(Eq. 3) Elasticity of demand = - dQ/dP

This measure may also be referred to as **price elasticity**. The minus sign in this equation is conventionally used because the quantity demanded is expected to vary inversely with the price that is charged. Elasticity of demand can also be estimated by looking at the change in demand that occurs after a change in price:

(Eq. 4) Elasticity of demand = $-((Q_1-Q_0)/Q_0)/((P_1-P_0)/P_0) = -((Q_1-Q_0)/(P_1-P_0))(P_0/Q_0)$

In this equation, the changes in quantity and price are both normalized by dividing by their values before the price change. The equation therefore can be interpreted as the percentage change in quantity divided by the percentage change in price.

To understand the importance of price elasticity, consider the two effects of a price decrease from P_0 to P_1 on total revenue PQ. Existing customers will pay less, because the price is lowered, and there will some loss of revenue:

(Eq. 5) Reduced revenue from original customers = $Q_0 (P_0-P_1)$

However, the lower price will attract new customers, so the quantity demanded will increase from Q_0 to Q_1, providing some additional revenue:

(Eq. 6) Additional revenue from new customers = $P_1 (Q_1 – Q_0)$

If elasticity is greater is greater than one, then the percentage increase in Q will be greater than the percentage decrease in P, and the added revenue from Eq. 6 will be greater than the loss of revenue from Eq. 5. If this is the case, demand is said to be "elastic", because there is a large response to changes in price. If elasticity is less than one, then the opposite is true: total revenue will decrease if prices are lowered, as the added revenue from new customers will be insufficient to offset the loss of revenue from existing customers. When elasticity of demand equals one, there will be no change in total revenue PQ, as the effect the change in price will be exactly offset by the change in demand.

Price elasticity is an important factor in infrastructure systems, because these systems tend to have high fixed costs and low variable costs. Maximizing revenue may therefore seem to be a reasonable goal, since the greatest obstacle to making a profit is having enough revenue to cover the fixed costs of the system. During the early portion of the 21st century, tremendous investments in satellite-based communications were justified in part upon the expectation that creating a very high-capacity system with very low prices would lead to extraordinary increases in demand – which is exactly what happened as technological advances lowered the costs of email, cell phones, and wireless access to the internet.

In the short run, demand tends to be more inelastic than in the long run. For example, when the price of oil rose dramatically in 2007 and 2008, people initially had to pay the higher price and perhaps cut back on non-essential driving. Over a period of a year or two, however, people were able to adjust in part by buying more fuel efficient cars and in part by figuring out how to combine errands, share rides, and use public transportation. Over a period of a decade or longer, the automobile companies can develop cars that use alternative energy sources, allowing people to drive more while using less oil.

Elasticity of demand is an important concept to keep in mind when evaluating infrastructure projects, because demand forecasts will drive decisions related to the size and therefore the cost and capacity of infrastructure. Forecasts based upon continuation of low prices or free access will lead to extravagant statements of infrastructure needs. Such has long been the case with urban road networks: with the exception of a few toll roads, there is no charge for using highways, and there should be no surprise that these roads have become so congested. Where tolls have been introduced, as in London and Singapore, it has proved possible to reduce traffic volumes and thereby limit congestion to reasonable levels. Water supply is another area where unrealistically low prices have in many locations led to unnecessarily high rates of consumption; future "needs" for water should take into consideration the effect of more rational pricing on consumption.

Based upon the concepts of equilibrium prices and demand elasticity, it is apparent that future demand for infrastructure will depend to a greater or lesser extent upon the prices that are charged. If demand is elastic, then pricing could have a dramatic effect on demand, and raising prices could be viewed as a way to reduce or avoid investments that increase infrastructure capacity. If demand is highly inelastic, then pricing will probably not be an effective means of limiting demand, and failure to expand capacity could lead to extremely high equilibrium prices, extremely poor service, or a need for regulating use or access. Elasticity of demand is therefore an important factor both in pricing infrastructure services and in forecasting demand for infrastructure. The next section continues the discussion of pricing in the context of the degree of competition among suppliers.

Pricing

This section introduces two markedly different pricing regimes: competitive markets and monopolistic pricing. In a competitive market, there are many suppliers and many potential customers, none of whom have the power to set prices. Instead, as described above, prices reflect an equilibrium between supply and demand. Not all markets are competitive, and it is possible that geography, politics, or economic factors encourage the development of companies or agencies that have a monopoly for particular goods or services. In the absence of regulation, a monopoly can set prices and customers have little power. Monopolies are not necessarily evil, because there are many situations where a single large supplier can produce goods or services at the lowest possible cost. Moreover, the danger of monopolistic pricing can be controlled by government regulation, so that the benefits of low cost production are passed on to society and not simply captured as excessive profits by the owners of the monopoly.

Marginal Cost Pricing in a Competitive Environment

In a competitive environment, prices will fall to marginal cost. A competitive environment is one in which many suppliers all have access to the same or similar technologies, and they are serving customers who are able to purchase goods or services from any of the suppliers. Under these conditions, a supplier who tries to raise prices above marginal costs will have a problem: another supplier will be willing to offer a slightly lower price and thereby capture the business. So long as the price is above the marginal cost, each sale will give the supplier some **contribution to overhead and profit**. Under perfect competition, no supplier has any pricing power, and prices are determined by the cost structure, the available technologies, and the level of demand.

Marginal cost pricing is efficient in the sense that prices reflect the actual cost of the product or the service. All of those who purchase the product or service are in fact willing to pay – and do pay – the marginal cost of production. While others may desire the product or service, they are unwilling to pay enough to make it worthwhile to any of the suppliers. Any supplier who can provide the product or service at a lower price is free to enter the market and make a profit by selling at or somewhat less than the prevailing price.

Situations where prices differ from marginal cost are likely to be inefficient in economic terms. If prices are too low, then demand will be too high and some users will be incurring costs that they would not be willing to pay for. If prices are too high, then many who would have been willing to pay a reasonable amount for the service will be unable to afford to make a purchase.

A major difficulty with marginal cost pricing arises in situations where marginal costs drop below average costs, as is commonly the case with infrastructure systems. In such situations, marginal cost pricing will not provide sufficient revenue to cover costs, and all suppliers will face bankruptcy. Technological advances and increasingly efficient production may help some suppliers stave off bankruptcy, but only the most efficient suppliers will be able to survive. In these situations, some kind of government regulation or subsidies may be needed to enable suppliers to remain in business. Regulation could take the form of limiting entry into the market or establishing prices at a level that allows suppliers to make a profit. Examples of governmental actions that limit entry include the following:

- Issuing taxi medallions in an attempt to limit the number of taxis to what will be efficiently utilized.
- Requiring railroads to seek regulatory approval before constructing new lines.
- Creating public utilities for communications or energy services.

Generally, when entry is limited, prices must be regulated to ensure that prices are reasonable.

Economies of Scale, Scope, and Density

A competitive market requires multiple suppliers who are free to determine whether or not to enter the market based upon the prevailing prices. If there are many companies, and it is easy to enter and exit the market, then supply and demand can quickly approach an equilibrium. However, the equilibrating process will be hampered if there are barriers to entry, such as the need to make large investments in order to be able to compete. For infrastructure-based systems, this is certainly an issue, as these systems by definition require substantial investments, and it will take time and effort to construct a competing system. Moreover, there are very likely to be economies in creating large facilities that can serve multiple purposes for many different users. Having competition among a great many – or even a few – smaller companies may be less efficient that having a single supplier. Larger systems may have three types of advantages over smaller systems: economies of scale, scope, and density.

Economies of scale exist when an increase in the size of the system results in reductions in cost. If C(Q) is the total cost of providing infrastructure adequate for usage Q, then there are economies of scale if:

(Eq. 7) $$C(Q_1 + Q_2) < C(Q_1) + C(Q_2)$$

For transportation, water resources, electric power grids, and other network-based systems, there will often be economies of scale because:

- A single management team can manage a larger system using the same basic information technology.
- The same advertising can be used for a wider audience.
- A larger network allows a company to provide single-company service to more customers, and direct service may be cheaper than service that requires cooperation among multiple suppliers.
- A larger network provides direct links between more locations, which in transportation or communication systems can be a major benefit for potential customers.
- Consolidated maintenance facilities can serve a wider area.
- The costs of energy and materials can be reduced because a larger company can negotiate lower prices from suppliers.

Economies of scope exist when it is more efficient to use facilities for two or more types of service than it is to use them for a single service. If $C(Q_i,S_i)$ is the cost of serving Q_i customers of type S_i and $C(Q_1,S_1,Q_2,S_2)$ is the cost of serving two groups of customers, then there are economies of scope if:

(Eq. 8) $$C(Q_1,S_1,Q_2,S_2) < C(Q_1,S_1) + C(Q_2,S_2)$$

A situation where there are clearly economies of scope would include highways, which serve commuters and intercity travelers moving in automobiles or buses along with local trucking and intercity trucking. Another situation would be a dam that is constructed for flood control that also can be used to generate electricity and support irrigation. If there are potential economies of scope, then there will be advantages to society from building joint facilities.

On the other hand, there are situations where it does not make sense to have a single facility for multiple services. Because of potential safety problems, pedestrians and cyclists are not allowed on high-speed, limited access highways. High-speed passenger trains cannot operate on tracks designed for freight trains, because high-speed trains cannot be safely operated on routes with sharp curves and frequent grade crossings. Swimming is not allowed in reservoirs, because of possible public health problems.

Economies of density exist when average costs decline as a result of adding more volume to an existing system:

(Eq. 9) $$C(Q_1 + Q_2) / (Q_1 + Q_2) < C(Q_1)/ Q_1$$

If applied to a single facility, economies of density would exist wherever scale economies exist. The distinction, however, between economies of scale and economies of density is very critical in transportation and other networks where there are many facilities and an extensive route structure. Costs in these networks relate to both the links and nodes of the system, and there are two major strategies for capturing more business, namely expanding the network or adding more volume to the existing network. In network systems, economies of scale refer to situations in which the network expands in proportion to the increase in demand, whereas economies of density refer to the effects of adding more traffic to existing facilities.

Even if there are no economies of scale, there could be strong economies of density. Much of the investment in transportation systems has been attempting to capture economies of density, e.g. by concentrating more cars on existing roads and more flights at existing airports. Most transport networks have strong economies of density up to the point where added traffic causes extreme congestion.

The distinction between economies of scale and economies of density can also be seen in restaurants and retail sales. Large retail outlets, such as Staples or Home Depot, are able to achieve lower fixed costs per unit of sales by having very large efficient buildings with managers and employees who can be more specialized and also more productive than they would be at smaller stores; with a larger work force, it is easier to adjust up or down for peak periods or slack periods. Big box retail stores therefore capture economies of density.

Fast food outlets such as McDonalds and Burger King, which have thousands of restaurants all over the country and around the world, are able to achieve scale economies. While they have some facilities that are larger than others, they have vast numbers of similar restaurants that benefit from brand recognition, common procurement, common design, and standard management. These restaurants have lower unit costs than the individual restaurants and smaller chains that they compete with, and they use extensive marketing to convince us that their food is not just cheaper, but just as tasty. People know what to expect when they walk into one of these restaurants, and therefore people are likely to go to these restaurants not just when they are near home, but also when traveling or vacationing in another state or another country. These companies clearly profit from scale economies.

Monopoly Pricing

Where there are possibilities for economies of scale, scope, and density, there can be strong forces leading to supply-side consolidation. The motivation initially is to save costs or to expand markets, but if competition is reduced, then it could be that a single company achieves monopoly pricing power. If demand is inelastic, this can lead to extremely high prices, not to mention extremely high profits.

If there are economies related to size, a larger company can always underprice smaller companies and still make a profit. Hence, they can drive competitors out of business, then, when no one else is left, they may have the opportunity to raise prices so as to maximize their profits. Naturally, the public and public officials are against monopolistic pricing, but they also are likely to favor lower prices. Therefore, in situations where there are strong economies of scale, public agencies will often allow one or a few companies to exist, but regulate their prices and perhaps their services. Examples of publicly owned or regulated monopolies include most transit systems in the United States, most agencies that provide water and sewage treatment, and most public utilities.

Productivity

Productivity, a classical consideration in economics, is defined as output divided by input. Productivity can be increased either by increasing the outputs obtained from the same level of inputs or by reducing the inputs required to obtain the same level of output. Improving productivity allows a company, an industry or a society to produce more and/or to consume fewer resources. Improving productivity therefore is generally viewed by most everyone as an important goal. Officials in the private sector believe that productivity improvements will lead to higher profits, while those in the public sector believe that higher productivity will lead to higher income for workers, lower prices for consumers, and better opportunities for growth in the economy. Achieving higher productivity motivates many infrastructure projects.

Measuring productivity is complicated by the fact that there are usually multiple types of outputs and inputs. Thus, to get the ratio of outputs to inputs it is necessary to have some kind of weighting system for measuring both outputs and inputs. For example, in looking at the productivity of the air transportation system, output cannot simply be measured as the number of passengers or the number of passenger-miles; it is necessary to consider the differences among short- and long-distance flights for business and non-business travelers. With water supply systems, it is necessary to distinguish among water supplies for residential, industrial, and agricultural users. With electricity companies, it is necessary to consider peak loads vs. off-peak loads. In all of these systems, inputs will include many factors that can be summarized under broad headings of labor, capital, land, materials, and energy.

One simplifying approach is just to consider a single measure of output and a single factor of production, leading to measures such as the total number of air passenger trips per airline employee or the amount of electricity generated per unit of investment. These single-factor measures tend to be somewhat arbitrary, as production really does require multiple factors, but such measures may be reasonable for measuring productivity changes for a single, fairly stable operation.

Another possible approach is to weigh outputs by their prices and to weigh inputs by their costs, perhaps using information from a base year for both prices and cost. If this is done, then the aggregate measure of output will be something close to "total revenue" and the aggregate measure of input will be something close to "total cost", and the ratio of output to input will be the ratio of revenue to cost. A variant of this approach is to assume that prices reflect marginal cost, in which case price can be assumed to be a measure of cost. Since price information is more readily available than cost information, this can be a useful assumption. If there is a meaningful measure of output, then the inverse of the price per unit may be a reasonable measure of productivity. Over time, changes in the price per unit can therefore be viewed as an indicator of changes in productivity.

For example, tremendous gains in productivity have been achieved in freight transportation over the past 200 years. Table 1 shows three factors that contribute to freight productivity: the cost per mile for construction, the tons carried per vehicle, and the miles traveled per day. The most commonly used measure of output in freight transportation is the ton-mile, which is one ton carried one mile. Typical costs and prices are shown in this table for two periods, the early 19th century and the early 21st century. The costs are current costs, unadjusted for inflation.

Before 1800, there were only two types of freight transportation that were generally available: wagons moving over bad roads and somewhat larger wagons moving over improved roads, which were usually limited to a few turnpikes radiating out from major cities. At that time, a turnpike was often just a dirt road that was maintained to allow slightly heavier vehicles to travel the straightest possible path between two towns. When using the turnpike, it was possible to use a larger wagon and to go a little faster simply because the road was smoother and a bit wider. Even with the turnpikes, transport was slow and expensive, and typical prices exceeded 15 cents per ton-mile.

Table 1 Increasing the Productivity of Freight Transportation

Technology	Cost per Mile to Construct	Tons/vehicle	Miles/day	Ton-miles per vehicle day	Typical Prices (cents/ ton-mile
Early 19th Century					
Rough road	$1-2,000	1 per wagon	12	12	20 to 40
Turnpike	$5-10,000	1.5 per wagon	18	27	15 to 20
Canal	>$20,000	10 to 100 per canal boat	20 to 30	200 to 3,000	5 to 10
Railroad	$15-50,000	500 per train	200	100,000 per train	3 to 5
Early 21st Century					
Arterial roads	$1-5 million	10 per truck	100	1000	10 to 50
Interstate Highway	$5-100 million	20 per trailer	500	10,000	10 to 15
Heavy-haul railroad	$1-5 million	5-15,000 per train	500	5 million per train	2
Inland waterway	Highly variable	1500 per barge; up to 40 barges per tow	50-200	6 million per tow	1

Rivers and canals allowed larger loads and longer daily hauls, as it is much easier to pull a canal boat along a river than to drive a horse and wagon up and down the hills. In the early 19th century, canals were built for upwards of $20,000 per mile; the expense was justified by the increased productivity for the freight carriers, and typical freight rates fell below ten cents per ton-mile. Canals were limited by geography, so rail technology had a great advantage as soon as it became available. Even with only 500 tons per train, a railroad allowed much more productive freight operations than was possible with small canal boats, and typical freight prices dropped below five cents per ton-mile. Technological improvements continued throughout the 19th and 20th centuries, so that today, the prices for freight transportation are actually lower than they were 200 years ago. The lowest prices are achieved for fully loaded vehicles traveling at the maximum speed on the main routes – tractor/trailer combination trucks on the Interstate Highway, heavy coal trains on high density, well-maintained rail lines (Figure 5), and tows of 40 barges moving along the major rivers.

This example used the ton-mile as a simple measure of output for freight transportation, even though the costs and benefits of transporting different commodities different distances can vary widely. For example, it is easier to move coal in single shipments of 10,000 tons than it is to move 10,000 tons of general merchandise as 200 separate shipments. Nevertheless, even though the ton-mile is far from a perfect measure of rail output, the cost/ton-mile remains useful in highlighting the dramatic productivity improvements that have been achieved in freight transportation.

Perceived productivity problems often suggest the types of projects that need to be undertaken:

- Peak demands may cause delays at bottlenecks in transportation or systems (so consider investing to relieve bottlenecks).
- Engineering constraints, such as weight limits on bridges or band-width limitations in communications networks, may restrict the usage of the system (so consider investing to increase the ability of the infrastructure to handle larger or heavier loads or higher volumes of usage).
- Lack of communication and control may inhibit efficient use of resources (so consider investing in communications and control systems).
- Facilities that were designed and built many years ago may no longer match what is needed today or in the future (so consider rehabilitating or expanding or redesigning facilities or networks).

Figure 5: Coal trains carrying up to 15,000 tons of coal operate on narrow rights of way through difficult territory like this canyon in Colorado. A double-track route like this can handle more than 100 million tons of freight per year – plus a pair of 79 mph passenger trains. The interstate highway is visible on the other side of the river. To minimize its footprint, it was double-decked for a portion of the route. There is also a bike path beneath the highway.

Photo: S.J. Martland 2000.

Image courtesy of Samuel J. Martland. Used with permission.

Measuring and Improving the Economy

Infrastructure projects have impacts that go well beyond the financial affairs of owners and users. Infrastructure allows and supports other economic activity, and the greatest benefits of investment in infrastructure may be the new opportunities made available to society. In evaluating large infrastructure projects, two types of economic impacts are commonly considered:

- The short-term boost to the local economy resulting from the planning and construction of the project.
- The long-term impact of the project on the region's economy once the project is completed, including the benefits to users of the new infrastructure as well as the permanent jobs directly linked to the project.

Constructing a light-rail line to the airport in order to relieve highway congestion and improve access does much more than provide jobs for operating the trains and maintaining the tracks; it also saves time for air travelers, airport employees, commuters who use the new line, and highway commuters who experience less congestion, as well as creating opportunities for developing real estate near the light-rail stations.

Short Term Economic Impacts: the Multiplier Effect of New Investment

The design and construction of a major project boosts the economy, because of what is known as the multiplier effect. Consider the construction of a new building in a city. Much of the investment cost will be made up of wages and salaries paid to local construction workers and payments to local merchants for materials and services. These workers may save some of their wages, but they are likely to spend most of it; likewise, the local suppliers will spend most of what they receive. The proportion of the new income that they consume is called the **marginal propensity to consume**.

Let's say that the construction of the building resulted in wage payments of $1 million to local workers and companies. This $1 million will in itself be an addition to the regional economy, but that is just part of the story. If the marginal propensity to consume is 0.5, then workers and companies will spend another $0.5 million – which will be another addition to the local economy. And that $0.5 million will go to other workers and companies who will save some and spend some. If they also save half and spend the rest, then there will be another $0.25 million added to the regional economy. And some of that money will also be spent. If half of the money is saved at each step, then the total addition to the regional economy will be $1 million (1 + 0.5 +0.25 + 0.125 + …) which will converge to $2 million dollars. In this case, the multiplier is 2, as each dollar invested leads to an increase of $2 in the regional economy.

In general, the total addition to the economy can be expressed as a function of the marginal propensity to consume MPC:

(Eq. 10) $$\text{Addition to economy} = \text{Investment in Region}\ (1 + MPC + MPC^2 + MPC^3 + \ldots)$$

So long as MPC is less than 1, this sequence converges to 1/(1-MPC). The factor (1-MPC) is the marginal propensity to save, so the multiplier effect increases inversely with the marginal propensity to save:

(Eq. 11) $$\text{Multiplier Effect} = 1/(1-MPC)$$

For example, if the marginal propensity to consume increases from 0.5 to 0.75, then the marginal propensity to save drops to 0.25. If so, then more money goes into the economy. The total addition to the regional economy would be:

(Eq. 12) $$\$1\text{ million } (1+.75+.75(.75)+(.75)(.75)(.75)\ \ldots) = \$1\text{million}/(.25) = \$4\text{ million}$$

With less money going into savings, the multiplier effect jumps from 2 to 4.

The multiplier effect would apply both to the construction phase and to the operations phase of a project. For infrastructure projects, however, since investment costs are so much higher than continuing costs, the greatest interest is in the multiplier effect from the investment. Multipliers are typically found to be between 2 and 3 for transportation and other infrastructure projects. Note that the multiplier effect relates only to the money spent within the region, so that a project that imported costly materials and used highly automated equipment would have a much lower regional impact than a more labor intensive project that used local labor and materials.

The presence of a multiplier effect motivates governments to initiate stimulus programs during a recession. In the short-run, the stimulus will be most effective in reviving the economy if it is directed toward projects and programs that direct money toward people who will be likely to spend most of what they receive. The long-run economic benefit will depend upon the success of the project in providing permanent jobs, making society more productive, or enabling other economic benefits to society.

Long-Term Economic Impacts: Gross Regional Product

The most common economic measure used to monitor the health of the economy is the **gross domestic product (GDP)**, which equals the sum of private consumption C, investment I, and government expenditures on goods and services G plus exports E minus imports M:

(Eq. 13) $$GDP = C + I + G + E - M$$

The growth in the economy is measured as the change in GDP, and growth in GDP is generally viewed as a critical objective for a nation. A growing economy provides opportunities for more jobs, higher wages, provision of more goods and services, and higher profits for companies. If GDP declines for two successive quarters, then the economy is said to be in a recession. Unemployment rises during recessions, wages may fall, and company profits decline. Thus, maintaining GDP is an important economic objective for a nation.

GDP is not a perfect measure, in part because there is more to life than economics. Even in the realm of economics, however, there is a major problem with GDP, because it fails to account for the losses associated with the depreciation of the capital stock of the country. Machines wear out, buildings age, infrastructure deteriorates, and these losses from depreciation will not be captured until and unless repairs are made or facilities are replaced. The net domestic product is calculated by subtracting total depreciation from GDP. Net domestic product is less commonly used because it is difficult to estimate depreciation of assets, while it is relatively easy to monitor consumer purchases, investments, government expenditures and foreign trade. Since the two measures will usually rise and fall in tandem, the GDP figure is what is most frequently used.

GDP is an aggregate measure that will not reflect conditions for particular regions, groups of people or sectors of the economy. However, similar measures can be estimated for each region of a country. The **gross regional product (GRP)** would be defined in the same manner, with the various factors defined so as to apply to the region, not to the nation. As with the national economy, growth in GRP will be a major economic objective for any region.

Jobs and average income are other important aspects of the regional economy. Adding jobs to the regional economy is always viewed positively, but especially so during a period of high unemployment. Higher-paying jobs are preferred, and local governments may provide tax breaks and other incentives to attract or to retain companies that have such jobs.

Economic models can be constructed to predict the impact of infrastructure investment on the regional economy. Such models may be able to show that transportation investments will make the region more attractive to new businesses or that investments in dams and irrigation will make local agriculture more profitable, leading to growth in all activities related to agriculture. Analysis may also show that investment in infrastructure is expected to have a measurable impact on congestion, public safety, or public health. Savings in time, reductions in risk, and improvements in health can be translated into economic benefits by using the average value of time for commuters, the expected savings in accident costs, and the expected reduction in health care costs. While such benefits do not result in cash flows that help pay for infrastructure investments, they are quantifiable factors that can help justify (and gain public approval for) public investments.

Trade

A great deal of infrastructure investment is based upon projections for population growth and growth in regional economies. Over the long-term, both types of growth depend to a large extent upon forces that act on a national or international scale, such as technological change and trade. **Technological change** results in new products, new materials, new development opportunities, and new processes for manufacturing and distribution. Over time, there can be marked changes in what types of things are produced, how and where they are produced, and how they are distributed around the world. These changes influence and respond to changes in **economic geography**, i.e. the location of people and economic activities throughout a region, a nation, or the world. And it is these changes in economic geography that require and motivate many investments in infrastructure.

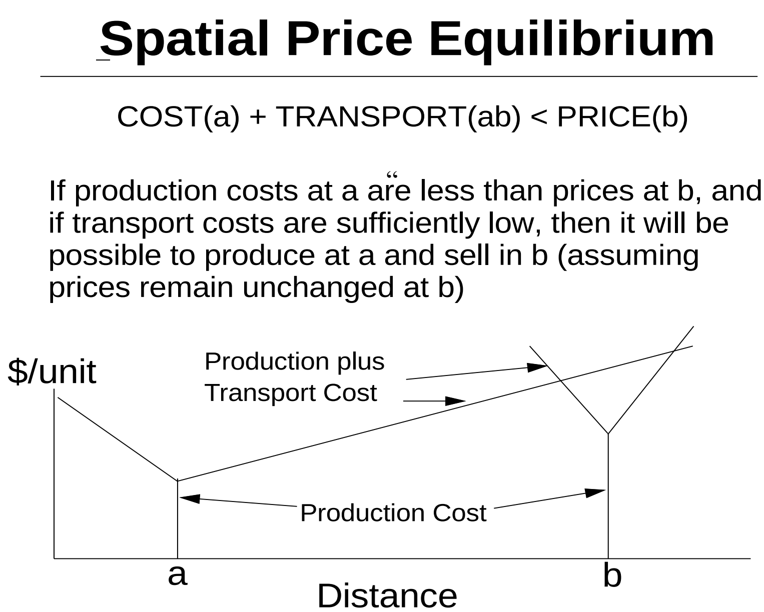
Trade is the exchange of goods among regions or countries. Transportation makes trade possible. Differences in regional resources, economies of scale in production, and differences in costs and capabilities make trade desirable. The ability to exchange currencies of different countries and to transfer monies between countries makes trade financially feasible. The ability of wealthy countries to buy vast amounts of goods and materials makes trade flourish.

Two key concepts are helpful in understanding how trade works and why trade is important. First, if it is possible to produce something for a lower cost in one region than in another, then there is an opportunity for trade, but only if transport costs are sufficiently low. **Spatial price equilibrium** is the process by which transport costs and manufacturing costs together determine prices for products that can be produced in one area and sold in another. Second, it makes sense economically for different regions to exploit their **comparative advantage**, i.e. to concentrate on what they each do best. Understanding these concepts is essential to understanding the global economy, and recognition that there is a global economy is essential for understanding the kinds of infrastructure investment that will be needed to support industrial production, trade, and population growth.

Spatial Price Equilibrium

To begin, consider a product that can be made in two locations. At location “a”, production costs are lower than at location “b”. T... ...ugh costs are lower at locati... “ ...st of all, costs are not prices. ...ey will share whatever mark... ...costs must be added to the m...

Figure 6 illustr... - ...s of this chart represents dist... “ ”. The y-axis represents the ... indicated by the vertical line...



Assume that transport costs T_{ax} from Manufacturer A to any potential location X are proportional to the distance D_{ax} from the manufacturer:

(Eq. 14) $T_{ax} = k_{ax}D_{ax}$

Thus, if Manufacturer A decides to market its product at location X, then the total cost will be:

(Eq. 15) $C_a = M_a + T_{ax} = M_a + k_{ax}D_{ax}$

A similar equation would apply for Manufacturer B:

(Eq. 16) $$C_b = M_b + k_{bx}D_b$$

The total costs C_a and C_b are both plotted in Figure 6. The costs for each manufacturer are Y-shaped, as total costs rise linearly by moving in either direction in this two-dimensional figure. The slope of the total cost line is the cost per mile for transporting the product, which is k_{ax} for Manufacturer A and k_{bx} for Manufacturer B. The slope is steeper for Manufacturer B, indicating that transportation costs are more expensive for that manufacturer. Manufacturer A will presumably capture the market for all locations where its total costs are less than those of Manufacturer B. At points where they are equal, the manufacturers will share the market. In the two-dimensional world depicted above in Figure 6, the total cost lines intersect in two places, one just to the left of Manufacturer b's location on the graph and one a little further to the right of that location. This indicates that Manufacturer B will only be serving its local market, while Manufacturer A will capture all of the rest.

In general, if two manufacturers of identical products are competitive in a market, then they must be charging the same price at that location. For a manufacture to compete and make a profit, the sum of their production cost plus transportation cost must be less than or equal to the prevailing price at that location. Prices will vary from one location to another, reflecting the differences in production and transportation cost. Over time, if transportation and production technologies are stable, a spatial price equilibrium will be achieved, and the markets served by each manufacturer will be well-defined.

Of course, neither production nor transportation technologies remain stable for very long. As we have already seen in this chapter, transportation costs have declined dramatically over the past 200 years, enabling today's manufacturers to compete globally. With low cost global distribution feasible, it makes sense a) to have large manufacturing facilities that take advantage of whatever economies of scale can be found in manufacturing and b) to have those manufacturers located in regions where costs are lowest, whether because of local labor rates or the local energy costs or the geographical position relative to sources of inputs and major markets. Because of the tremendous improvements in freight transportation productivity, it is now feasible to manufacturer many consumer goods in Asia, where labor and production costs are very low, and to ship those goods on large container ships to major ports for distribution throughout the rest of the world.

Comparative Advantage

The unequal distribution of resources, including capital and skilled labor as well as natural resources, is another force promoting trade. Because of accidents of location or history, one region may be able to produce certain products at a lower cost or higher quality than other regions. If this region makes an excess amount of such products, then it can sell them to other regions and use the proceeds to purchase other types of goods from those regions. For example, one country may be very good at making automobiles, while another country is very good at agriculture. Opportunities for trade would seem pretty clear: trade automobiles for food, and allow the country to concentrate on the products where they are the best.

The potential benefits of specialization were first highlighted nearly two hundred years ago by David Ricardo, who developed the theory of **comparative advantage** in 1817. Samuelson summarized this theory as follows:

> "Whether or not one of two regions is absolutely more efficient in the production of every good than is the other, if each specializes in the products in which it has a *comparative advantage* (greatest *relative* efficiency), trade will be mutually profitable to both regions. Real wages of productive workers will rise in both places."[2]

[2] Paul Samuelson, **Economics: An Introductory Analysis**, McGraw-Hill Book Company, New York, 1964, 6th edition, p. 665.

This theory is the basis for reducing tariffs and other barriers to trade. Tariffs are taxes that are charged on inputs as a means of protecting local manufacturing. However, the theory of comparative advantage indicates that it is better to allow imports, so that local workers and local capital can be put to work more productively in areas where the region enjoys its greatest efficiency relative to other regions.

Currency Exchange and International Banking

International trade depends upon a banking system that is able to do two things. First, there must be a common medium of exchange, so that the money used in one country can be used or converted into an amount of another country's money that has the same value. Second, it is necessary to have some system of credit so that a person in one country can borrow the funds needed to buy goods that will be exported from a second country and perhaps transported and sold in a third country.

Today, when it is easy to stick a credit card into an ATM to get local currency when traveling abroad, it is difficult to imagine how important – and how difficult - it was for traders to have access to a banking system in order to carry out their business without personally carrying vast sums wherever they went.

The exchange rates between currencies can be based upon market forces or regulatory forces. Major newspapers provide daily reports on the exchange rates for the major currencies. In early 2009, for example, $1.00 was worth about 0.77 euros or, to put it the other way around, one euro was worth about $1.30.

At times, exchange rates will be quite volatile. In September 2008, when I traveled to Ireland, the euro was worth $1.60. While I was in Europe, there was a worldwide credit crisis, major banks appeared in imminent danger of collapse, and the value of the euro dropped to about $1.35 by the end of my vacation. Although the prices of our hotels and our meals remained unchanged – in euros – it appeared to us as though everything was now 15% off! This change made our trip a little bit cheaper, but this same change affected every transaction between anyone in the U.S. doing business with anyone in Europe. Suddenly, everything priced in euros was 15% cheaper for anyone who had dollars to spend – and everything priced in dollars was 15% more expensive for anyone who had euros to spend. A change of this magnitude is equivalent to putting a 15% tariff on everything exported from the US into Europe and having a 15% sale on everything imported to the US from Europe. Changes of this magnitude have broad repercussions on international trade and travel, even without a credit crisis.

A credit crisis can be devastating to trade and economic growth. Without credit, it is hard for businesses to get the loans they need to expand production and it is hard for consumers to borrow money to buy houses, cars and other items. The credit crisis in late 2008 and early 2009 resulted in stock markets plunging, the auto industry teetering upon bankruptcy, and many banks and investment banks collapsing. Without credit, trade declined abruptly and the world economy slipped into a serious recession.

Making Decisions: Utility and Sunk Costs

Economists use the concept of **utility** as a way to understand how individuals make decisions. It is assumed that people act so as to maximize their utility, subject to budgets for both time and money. Utility is a useful concept, even though few of us will be able to say why we do or do not do something or why we prefer one product over another. It is possible to study utility by documenting the choices that people make or by conducting surveys, i.e. by considering what are called **observed preferences** or **stated preferences**. Analysis of actual choices is likely to provide better insight into behavior, but it is much easier to obtain detailed information by using surveys and documenting stated preferences. For example, a survey could ask people to say whether or not they would buy a particular product for various prices. More complex surveys could be devised to explore quality of service, timing, and other factors that might be important in addition to price.

For example, consider the journey to work. A person may have the choice of driving alone, riding with a friend, or taking the bus. Direct observation may show that this person drives alone 60% of the time, rides with a friend 20%

of the time, and takes the bus 20% of the time. An interviewer can probe further, seeking to understand how cost, travel time, work schedules, weather, errands, and shopping factor into the decision. Utility models may be constructed based upon the actual decisions or the stated preferences. These models will typically include variables that reflect cost, service quality and convenience. The result of a utility analysis will be something like "people seem to value the time spent commuting at something close to their average wage". Such an estimate of the value of time could be used in estimating the benefits of a transportation project that saved time for commuters or other travelers.

Economic decisions concern future costs and benefits. Money spent in the past should not affect what we decide to do today, and such costs can be viewed as **sunk costs**. For instance, if you are about to buy a new car, and you plan to trade in your old car, it does not matter – to you or to the car dealer – what you paid for that car. What matters is what the car is worth today, which will depend upon the condition of the car and the demand for used cars. On a larger scale, when trying to decide whether or not to buy or sell a building, it does not matter what that building cost to build. It is only the market value of the building that will affect the price. Of course, if you have yourself put a great deal of money into buying a car or your house, you may well perceive that the car or house is worth a lot more than anyone else does, but that is only a factor in deciding whether you are willing to part with it. The current market value is what should enter your economic analysis.

Summary

This chapter has introduced supply, demand, equilibrium, competitive and monopolistic pricing, productivity, utility and other economic concepts that are relevant to project evaluation. These concepts provide a framework for thinking about needs, projects, and project evaluation.

Supply and Demand

The **supply function** describes the amount of output that will be provided as a function of the price per unit that is sold. The **demand function** describes the amount of output that will be purchased as a function of the price per unit. The **equilibrium price** is the price for which supply will equal demand. In most complex systems, there will be continual changes in both supply and demand, and it is more realistic to think about systems moving toward equilibrium rather than always being in equilibrium, especially for systems where it is costly and time-consuming to adjust capacity. Congestion, delays and poor quality are likely when demand exceeds supply, while underutilization of equipment and reductions in the work force of suppliers will be common when supply exceeds demand.

The **elasticity of demand** with respect to price can be estimated by observing the effects of price changes on demand. If demand is elastic, then demand will be more responsive to price changes, and an increase in price will lead to a decrease in total revenue. Demand tends to be more elastic in the long-run than in the short-run, as people and businesses will generally find ways to reduce their dependence on higher-priced goods and service.

Productivity

Productivity is defined as the ratio of output to input. Improving productivity is an important objective, because productivity improvements make it possible to produce more goods and services using fewer people and resources. Many projects eliminate productivity problems related to bottlenecks, constraints on usage, inadequate control, or outmoded facilities. Productivity may also be improved by changing the structure, design and size of networks or facilities so as to achieve economies of scale, scope, or density. **Scale economies** exist when expanding the size of the system leads to reductions in average cost. **Scope economies** exist when it is cheaper to use facilities for multiple uses. **Density economies** occur in a network when more volume is concentrated on each route.

Pricing

In a **competitive environment**, no individual supplier has the power to set prices, and prices will fall to marginal cost. In infrastructure-based systems, **marginal cost pricing** will generally be well below average cost as long as the system is operating below its design capacity. Thus there may be a need for price regulation or subsidies to ensure that revenues are sufficient to cover total costs of operation. If demand approaches capacity, then marginal costs for both users and operators will rise as delays and high utilization levels make it difficult to use and maintain the system.

If a supplier has a **monopoly**, it can set prices well above marginal costs so as to maximize profits. Monopolies may also be slow in adopting new technology or expanding capacity to meet demand, and they may display little concern for service quality. However, for many infrastructure-based systems, there are tremendous economies of scale and density, so that the cost of service can be greatly reduced by limiting competition. Thus, many transportation companies and public utilities are allowed to operate as monopolies in order to achieve cost savings, while being subjected to regulation in order to ensure reasonable prices and service.

Measuring and Improving the Economy

Public officials and the general public are naturally interested in expanding economic output, which is commonly measured as the **gross domestic product (GDP)**. GDP is the sum of all private consumption, private investment, government expenditures and net exports. Other measures of the economy include **total jobs**, **unemployment** levels, and **average income** per person or per family. All of these measures can be developed for a region as well as for a country.

A major project will have both a direct and an indirect effect on the regional economy. The direct effect will be related to the jobs created and the expenditures required to complete and subsequently to operate and maintain the project. In addition, there will be a **multiplier effect**, because the people who work on the project and the companies that sell materials to the project will spend much of what they earn, whether on food or cars or housing, and other people and other companies will enjoy some added income.

Trade

Trade allows regions to specialize in economic activities where they have a **comparative advantage** relative to other regions. By producing more of what they need for some types of products, they are able to trade for other things that they need or desire. The ability to trade is dependent upon the ability to transport goods efficiently between regions, because of **spatial price equilibrium**. In order for trade to make sense, the cost of producing something in one location plus the cost of transporting the product to another location must be less than the price that can be charged in that location. Investments in transportation systems have produced dramatic reductions in transport costs, thereby enabling the shift of manufacturing, mining, agricultural production, and other activities to the regions of the world with the lowest costs. The global economy reflects low transportation costs and the fact that there are generally high economies of scale in production.

Banking and currency exchange are another essential aspect of global trade. Exchange rates between currencies of different countries may be determined by market forces or by regulations. Over time, **exchange rates** may vary substantially, which will tend to change the patterns of trade by making some countries relatively cheaper and other relatively more expensive. Growth in trade and changes in trade routes are important considerations in many infrastructure projects.

Making Decisions

Despite the fact that we know ourselves often to be less than rational in our decisions, economists assume that individuals will generally make decisions so as to maximize their own **utility**. Utility is a rather vague – but thoroughly useful – concept that can incorporate disparate factors such as cost, convenience, reliability, safety or aesthetics that might affect our choice of a new car, a new house, or where to eat dinner. By observing what decisions people make (**revealed preferences**) or asking people about hypothetical choices (**stated preferences**), it is possible to infer what factors they consider in making choices. Those who plan projects must, at some level, consider how many people will use the completed project (road, water system, park or office building) and how much they will be willing to pay for their use of it.

When evaluating proposals, only future costs and benefits need to be considered. Money spent in the past is a **sunk cost.** Whether that money was well-spent or wasted does not and should not affect decisions concerning what to do in the future.

Manchester, New Hampshire

Water power enabled Manchester to become a dominant manufacturing center during the 19th century. When the mills closed, the old buildings were transferred into office space museums, restaurants, and small businesses, and walkways were constructed along the Merrimac River in order to attract visitors.

Resource: Project Evaluation: Essays and Case Studies
Carl D. Martland