



## Chapter 11

# Sustainable growth— An economic perspective

**Kazuhiro Ohta**

Professor, School of Commerce, Senshu University

**Mariko Futamura**

Associate Professor, Department of Economics, Tokyo Woman's Christian University

### 11.1 Cost-benefit analysis

#### 11.1.1 The purposes and theoretical foundation of cost-benefit analysis

Cost-benefit analysis (CBA) is applied to evaluate the economic effect of transportation facilities such as roads and railways and to support decisions regarding whether to take on projects.<sup>1)</sup> A federal waterway project by the Tennessee Valley Authority, which was begun during the 1930s as part of the New Deal in the United States, was the first systematic evaluation using CBA. The purpose is to determine whether a sufficient development effect would be realized when investing the large amounts of money required to construct dams and other massive projects.

CBA is applied not only to transportation facilities but to a wide range of evaluations for public investment. The basic idea is to calculate and compare in terms of monetary units the costs required for a project and the benefits derived from it. In the case of transportation facilities, monetary costs include those required for development (construction), ongoing maintenance, and other costs paid by public entities. There are also cases where negative effects to society resulting from the project, such as worsening of the environment, are included in the calculation as additional costs or negative benefits.

The main benefits from transportation facilities include benefits from timesaving, benefits from reduced movement costs (in the case of road development, fuel savings), benefits from improved safety, and benefits from improved comfort. Due to the nature of transportation facility development, benefits due to time savings account for a majority of the overall benefits. Several evaluation methods have been developed for costs and benefits such as time, safety (reduced accident risk), and comfort.

#### 11.1.2 Evaluation criteria in CBA

Because of limitation of project budgets (financial resources), CBA is applied not to determine whether projects should be carried out, but rather to make a relative comparison for selecting between alternatives. There are three main criteria for project evaluation:

## (1) Net present value method

Net present value is given by the following equation:

$$NPV = B - C - K = \sum_{t=0}^T \frac{B_t}{(1+i)^t} - \sum_{t=0}^T \frac{C_t}{(1+i)^t} - K$$

Here,  $NPV$  is the net present value,  $B$  is the present value of total benefits in base year 0,  $C$  is the present value of total maintenance costs in base year 0,  $K$  is the present value of construction costs in base year 0,  $t$  is the year,  $T$  is the evaluation term (durability in years),  $B_t$  is the benefits in year  $t$ ,  $C_t$  is the maintenance costs in year  $t$ , and  $i$  is the social discount rate. In this evaluation method, the larger the  $NPV$ , the better the project.

## (2) Benefit-cost ratio method

In this method, the larger the benefit-cost ratio, the better project. Benefit-cost ratio is defined as the ratio of the benefits of a project relative to its costs. In practice, two ratios can be used:  $(B-C)/K$ , which is the net benefits per unit of investment (construction costs); and  $B/(C+K)$ , which is the ratio of gross benefits to total costs. As both ratios represent cost-benefit ratios, it is necessary to choose in advance which ratio is used for the project appraisal.

## (3) Internal rate of return method

Internal rate of return represents how much the rate of return from an investment increases, and the larger the internal rate of return, the better the project. The internal rate of return  $r$  is calculated by solving the following equation:

$$\sum_{t=0}^T \frac{B_t}{(1+r)^t} - \sum_{t=0}^T \frac{C_t}{(1+r)^t} = K$$

Internal rate of return is the criterion most consistent with economic theory. However, in cases where huge costs occur at the end of the evaluation period, such as when nuclear power plants are decommissioned,  $r$  can sometimes represent multiple possible solutions. Note that this rarely occurs in transportation improvement projects, so this method is recommended for the project evaluation.

## 11.1.3 Foreign exchange rate issues

In cases where funds are procured domestically, the evaluation methods described above can be applied regardless of whether funding will be through taxes or bonds. In cases where funding occurs through international investment, however, variation in future foreign exchange rates must be taken into account. In developing countries in particular, it is important that project evaluations consider the ability of the nation to repay foreign debt.<sup>2), 3)</sup>

## 11.2 Balanced and unbalanced growth

### 11.2.1 Theories of balanced and unbalanced growth

#### (1) Nurkse's balanced growth theory

The scale of a country's economy is determined by its trading conditions with other countries, in addition to other factors including the three major factors of production (land, private capital, and labor), as well as the country's saving rate, inflation rate, social overhead capital, and technology level. There is thus a wide variety of aspects for analysis in economic growth theory, one of which is research regarding economic growth paths.

Nurkse's balanced growth theory<sup>4)</sup> is one perspective regarding the path that a country takes during economic growth. Nurkse gave a lack of private investment as one cause related to the failure of developing countries to realize economic growth, and proposed balanced growth as a way of inducing private investment, on the assumption that balanced increases of production would expand markets. This theory is not well supported in recent years.

#### (2) Hirschman's unbalanced growth theory

Another approach is Hirschman's unbalanced growth theory.<sup>5)</sup> There are various difficult-to-solve problems that impede economic growth in developing countries, and such countries do not possess sufficient resources or capital to simultaneously solve them all. Accordingly, to pursue rapid economic development, the best strategy is to focus investment of resources and capital on strategic growth industries, and to maintain such a disequilibrium. Such strategic industrial growth would later have positive repercussions for other industries and contribute to nationwide economic growth.

### 11.2.2 Social overhead capital and private capital

Unbalanced growth theory can be applied to the balance between social overhead capital (public investment) and private capital (private investment). Figure 1 shows the path of each growth strategy, with A as a departure point and B as a destination. Three examples of growth paths between points A and B are shown. The horizontal axis indicates stock levels of social overhead capital, and the vertical axis indicates stock levels of private capital. In each case higher stock levels indicate

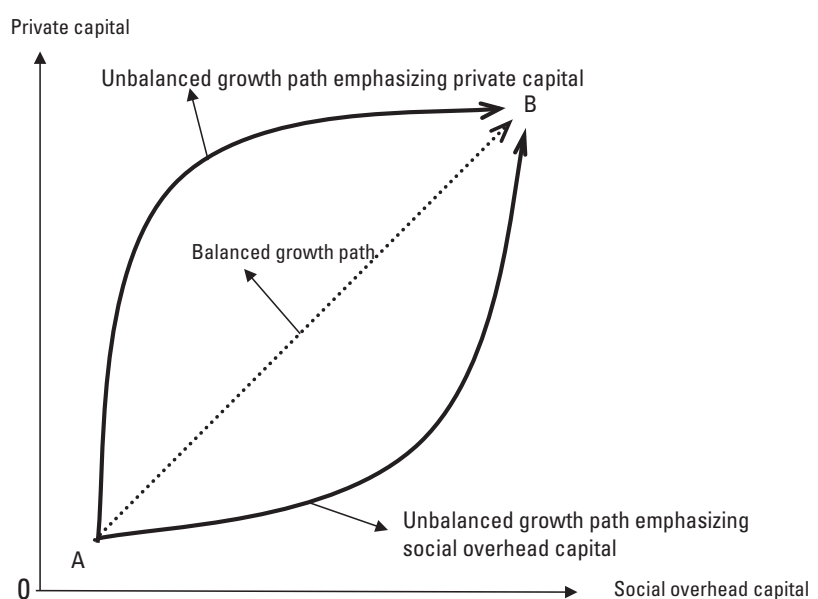


Figure 1. Balanced and unbalanced growth paths

higher potential productivity and thus higher potential economic growth.

In Fig. 1, the dotted line at a 45° angle is the path of balanced growth. In other words, investment occurs in a balanced manner such that marginal productivity is equalized between private and social overhead capital. In contrast, the curve at the top is a growth path in which private capital takes precedence over social overhead capital, and the curve at the bottom conversely prioritizes social overhead capital development. The issue at hand is the speed and cost required to move from A to B. Unbalanced growth theory states that an unbalanced growth path arrives at B more quickly and at a lower cost (specifically, a lower opportunity cost of capital) than the balanced path does.

Yet when considering whether to prioritize private or social overhead capital, it is insufficient to consider only the opportunity cost of capital. This is because while decision makers behind private-sector investment are private individuals, social overhead capital investment is exclusively a public entity. This is particularly true in the case of transportation facility development, where even within the same country the emphasis on private or social overhead capital will vary from region to region.

In cases where economic growth is so high that social overhead capital development cannot keep up, an unbalanced growth route that emphasizes private capital will be taken. From the viewpoint of transportation facility development, this is a case of transportation social overhead capital development aimed at keeping up with emerging demand. In other regions where private economic activities are stagnant, the government often may undertake transportation facility development for regional vitalization, which means that the government takes an unbalanced growth path that emphasizes social overhead capital. This is an example of transportation social overhead capital development that precedes economic development. In this case, failure to attain a sufficient regional development effect would result in failure to reach point B and the development of transportation facilities could be considered wasteful.

### 11.2.3 Forward and backward linkage effects

There are two types of economic effects resulting from public investment in transportation facilities: forward linkage effects and backward linkage effects.

Forward linkage effects are benefits (economic effects) from public services provided by the facilities developed through public investment. In other words, these are effects in which public investment results in increased social overhead capital stock, thus increasing potential productivity. The forward linkage effects of a project are recorded as benefits of the project in CBA.

Backward linkage effects are the economic effects of increased demand for a resource that is devoted to public investment, in particular economic effects in the regional economy. In other words, public investment activity results in increased demand for materials and labor, thus increasing income to material and labor suppliers. Backward linkage effects are often emphasized as being important economic effects of public investment programs for regional economies.

## 11.3 Economic policy against traffic congestion<sup>6)</sup>

### 11.3.1 What is congestion?

Congestion is the result of a concentration of relatively large demand in comparison to the capacity of facilities or equipment, and causes many monetary and nonmonetary costs that do not arise in cases of no congestion. In the transportation area, these include problems such as crowding on trains and congestion on road networks. In any case, it is assumed that supply levels cannot be changed in the short-term and that collective consumption is possible up to a certain level. Exceeding that level results in external diseconomies, indicating conditions that hinder the intended use. In this paper, we mainly deal with road congestion problems that many cities in the world suffer.

### 11.3.2 Economic understanding of congestion

Roads are a resource for which collective consumption is possible up to a certain level, allowing users to drive smoothly. However, when a road becomes congested, the driving speed on the road decreases, increasing costs such as time and fuel costs required to reach a destination.

Figure 2 shows such an example, with traffic flow on the horizontal axis and required costs on the vertical axis. Road capacity  $F_0$  is the upper limit on possible equal consumption, and when automobiles in excess of this limit enter into the road, marginal costs begin to increase. In other words, the inflow of additional traffic results in decreased driving speed and increased time requirements for

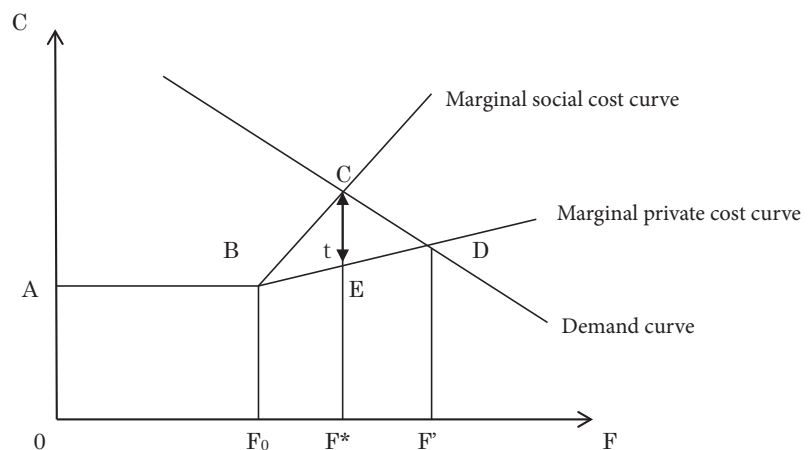


Figure 2. Occurrence of congestion

each driver, increasing marginal private costs. All drivers experience this increased cost resulting from the inflow of additional traffic in a similar way, so the marginal social cost curve diverges.

Following the concept of a Pigovian tax from microeconomics, this external diseconomy can be internalized by imposing a tax rate  $t$ , allowing attainment of an optimal congestion level  $F^*$ .

### 11.3.3 Example of introduction of a congestion charge

Road congestion is a significant problem in many cities throughout the world. Although the aims are various, many cities such as Singapore, Oslo, and London have introduced congestion charging to downtown areas. London was the first city in an industrialized nation to attempt this, with a scheme designed to reduce inner-city traffic.

Beginning with the 1964 Smeed Report, there have been many studies and discussions on introducing a road congestion charge in London, but establishment of the Greater London Authority in 1997

and the 2000 election of a mayor who supported the idea laid the groundwork for actual implementation. In 2003, the London Congestion Charging Scheme was introduced for improving traffic flow. Under this scheme, automobiles entering areas designated by Transport for London between 7:00 and 18:00 on weekdays were subject to a charge of £5 per day. The charge was incrementally raised, and as July 2014 stands at £11.5 per day. Signs such as the one shown in Fig. 3 are posted at entrances to the congestion charge zone, and cameras record vehicle license plates to create records of who should be charged. All the money collected as a road congestion charge is designated for use toward developing and maintaining public transportation.<sup>7)</sup>



**Figure 3. Entrance sign in London indicating the congestion charge zone<sup>(1)</sup>**

According to a published fact sheet, the congestion charging scheme has resulted in a 27% reduction in the number of vehicles in the congestion charge zone, as compared to 2002 figures before the introduction of the scheme. Bicycle usage has increased by 66%, indicating a shift away from the use of automobiles.

## 11.4 Economic policy and environmental problems<sup>6)</sup>

### 11.4.1 Transportation and environmental problems facing modern society

There are many environmental problems caused by transportation, including air pollution, global warming, noise pollution, and vibration. In particular, many countries are working hard to develop measures for reducing atmospheric pollutants and greenhouse gas emissions. All modes of transportation increase environmental load to some extent, but on a per-emissions-unit basis automobiles are particularly problematic.

Atmospheric pollutants have a direct negative effect on human health, and materials such as nitric oxides, sulfur oxides, and particulate matter are generated in areas with many automobiles. Global warming is a result of the production of large quantities of greenhouse gases, with carbon dioxide considered to be a particularly large contributor. Carbon dioxide itself does not have a direct effect on human health, but it is believed that we are producing it in such large quantities that we are increasing the temperature of the Earth's surface, which in the future will lead to large effects such as rising sea levels and changes in vegetation.

### 11.4.2 Understanding environmental problems from an economic perspective

In economics, environmental problems are treated as the results of external diseconomies that lead to

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(1) From the Transport for London website

overuse of a given service. Such overuse creates deadweight loss, so social surplus is not maximized.

As Fig. 4 shows, a Pigovian tax can internalize this external diseconomy by imposing a tax rate  $t$  that attains an optimal level  $F^*$ .

### 11.4.3 Measures for addressing environmental problems

As discussed in the section above, environmental problems are caused by excess gaseous and particulate emissions. Measures that can be considered for reducing such emissions from automobiles can be categorized as those that (1) improve automobile performance, (2) suppress automobile usage, and (3) promote efficient automobile usage. Respective examples of such measures are (1) lowering the discharge rate of pollutants an automobile releases, (2) suppressing automobile usage through a switch to public transportation, and (3) reducing the number of vehicles used through more efficient utilization of automobile space.

A number of policy techniques can be applied to realizing such measures, but economic methods that utilize market mechanisms can allow for smoothly achieving these goals.

In the case of (1), reducing the acquisition and holding taxes associated with environmentally sound vehicles are effective; consumers would be more likely to select economically sound vehicles that carry a lower tax burden, thereby pushing automobile manufacturers to develop more of such vehicles and improving the average fuel consumption of new vehicles and improving the average performance of vehicles on the road. In the cases of (2) and (3), as described in Section 11.4.2, additionally imposing fuel taxes can promote higher efficiency at the usage level.

### 11.4.4 Economic instruments targeting the automobile environment in Japan

In Japan, a policy called the “greening of automobile-related taxes” has been implemented since 2001 with the goal of improving the environment through increased automotive performance. This policy lowers acquisition and holding taxes for

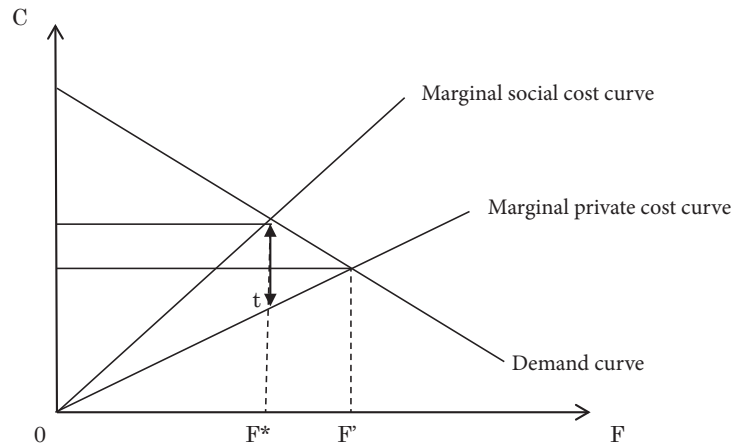


Figure 4. Environmental diseconomies and Pigovian taxation

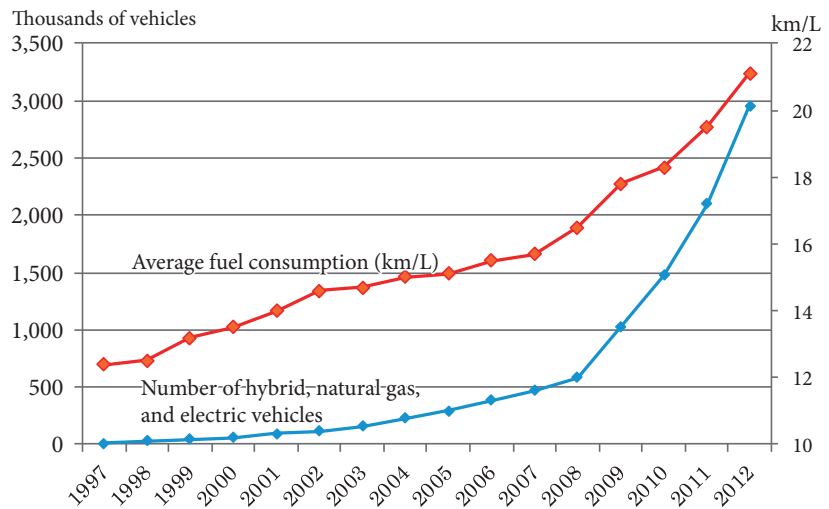


Figure 5. Performance improvement trends for automobiles in Japan

exceptionally environmentally friendly vehicles, while increasing taxes for vehicles with poor environmental performance.

This has resulted in consumers selecting more low-emission vehicles with lower taxes and in manufacturers making efforts to improve environmental performance of vehicles, thereby increasing ownership rates of hybrid, electric, and natural gas vehicles and improving overall per-liter fuel efficiency (Fig. 5). Such efforts have resulted in a trend of reduced carbon dioxide emissions from the transportation sector in Japan.

## 11.5 Economic regulations and deregulation

### 11.5.1 Regulations on transportation services

Transportation operations are generally considered susceptible to public intervention. Regulations can be roughly divided into “social regulations” and “economic regulations,” with social regulations being qualitative regulations related to safety and the environment, and economic regulations being quantitative regulations related to effects on market supply and demand. Economic regulations are further categorized as price regulations and entry regulations. The supply and demand of transportation industries in particular have been adjusted, with public competition inhibited. In recent years, however, there has been a worldwide movement toward deregulation, with the goal of improved efficiency through competition in transportation markets.

### 11.5.2 Necessities and limits of regulation

One might ask why transportation markets in particular have long been subjected to economic regulation. One reason is that economies of scale in a given market are believed to lead to natural monopolies. Economies of scale often occur in industries with large fixed costs, and when companies freely compete, they bring down the prices, compete on service quality, and create “destructive competition.” When competitors leave the marketplace and a natural monopoly has arisen, the victor is free to enjoy monopoly benefits and consumers will then be faced with monopoly prices. Furthermore the investments made by competitors that leave the market become “sunk costs” that cannot be recovered, representing a social loss.

Transportation markets have many of these features, and the high demand for transportation services would result in large effects, so long-lasting monopolies and oligopolies have been accepted in exchange for their being the subject of price regulations. Note that price regulations have been applied under the “full cost principle,” which holds that necessary revenue equates to costs occurring under efficient management plus a fair profit.

However, the full cost principle does not provide operator incentives for cost reduction, and has led to inefficient management and further increased pricing. According to the theory of contestable markets presented by Baumol and others since the mid-1970s, this led to changes in public intervention in the transportation industry.<sup>8)</sup>



### 11.5.3 Contestable market theory

A contestable market is one with free entry and with no cost associated with leaving the market, allowing hit-and-run strategies. When a market is completely contestable, existing companies act efficiently, for reasons described below.

In the case where an existing company has a monopolistic or oligopolistic market and thus enjoys excessive profits, new companies can enter the market offering a lower price, thereby capturing all the customers and making a profit. In response to this, an existing company offer equivalent or lower prices, the new company will lose their profits, forcing them out of the market. By the same theory, even in the case where an existing company has a monopolistic market, one in which entry and exit by new companies does not entail sunk cost, the threat of new participation promotes the setting of efficient prices.

### 11.5.4 Expansion of deregulation

Taking contestable market theory as a theoretical background, in 1978 the United States deregulated domestic airline services, and after that, transportation segment deregulation spread around the world. Examples include bus and airline industries in the United Kingdom, as well as the airline, taxi, and trucking industries in Japan.

In the mid-1990s, the Japanese airline industry moved from being non-competitive to being competitive, and ease of market entry and pricing deregulation were promoted. The result was an influx of new operations in the industry, including even new operations by existing airline companies, accompanied by diversification of pricing and services. The Japanese airline industry is still not yet a true contestable market, however, due to congestion at airports such as Tokyo's Haneda Airport preventing free market entry. In such cases, the role of public entities is still large in regard to issues such as dividing new airport slots among airline companies.

#### References

- 1) Mishan, E. J., and E. Quah. 2007. *Cost-Benefit Analysis*. 5th edition. Routledge.
- 2) Brent, R. J. 1998. *Cost-Benefit Analysis for Developing Countries*. Edward Elgar.
- 3) Dinwiddie, C. L., and F. J. Teal. 1996. *Principles of Cost-Benefit Analysis for Developing Countries*. Cambridge University Press.
- 4) Nurkse, R. 1961. *Patterns of Trade and Development*, mimeo, 1959. Blackwell.
- 5) Hirschman, A. O. 1958. *The Strategy of Economic Development*. Yale University Press.
- 6) Bamford, C. G. 2006. *Transport Economics*. Heinemann.
- 7) Transport for London. 2014. "Transport for London Congestion Charge Factsheet." *Transport for London*. Accessed September 25, 2014. <https://www.tfl.gov.uk/cdn/static/cms/documents/congestion-charge-factsheet.pdf>.
- 8) Baumol, W. J. 1982. "Contestable Markets: An Uprising in the Theory of Industry Structure." *American Economic Review* vol. 72, No. 1.

#### Recommended Reading

- 1) Boardman, A., D. Greenberg, A. Vining, and D. Weimer. 2013. *Cost-Benefit Analysis: Concepts and Practice*. 4th edition. Pearson.
- 2) Vickers, J. and G. Yarrow. 1995. *Privatization*. MIT Press.