New Frontiers in Regional Science: Asian Perspectives 1

Hirotada Kohno

# Economic Effects of Public Investment

## An Emphasis on Marshallian and Monetary External Economies

Springer

# New Frontiers in Regional Science: Asian Perspectives

Volume 1

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# Preface

So far, we have expressed the intention of our studies in the form of economic effects of public investment and public investment criteria—that is, the following two themes have been subjects of inquiry:

A: Theory and measurement of the *indirect* economic effects of public investment, based on the Marshallian and monetary external economies
B: Theory and measurement of the public investment criteria, based on the interregional input-output programming model

This time, these two are separated and will be published in separate volumes.

There has always been the theme of public investment criteria in our deep thoughts whenever the economic effects of public investment are argued.

Although the title of this volume is *Economic Effects of Public Investment*, the argument proceeds in content in the form of (A) above, that is, with the emphasis on the "indirect."

For what reason should we adhere to the Marshallian and monetary external economies? The reason is this: the new epoch-making theory was desired in response to the paradigm-change-like background of the times in the transportation field of the new construction of ultra-gigantic public investment; public facilities (infrastructure) such as the Meishin (Nagoya–Kobe) Expressway (July 1, 1965), the To-Mei (Tokyo–Nagoya) Expressway (May 26, 1969), and the Tokaido New Trunk Line (October 1, 1964); and other projects during a period of about 20 years (1955–1975).

Corresponding to such events, in the investigative research field, two large works were of pressing need, of the preparation–learning–aftercare concerning the *Report on the Kobe–Nagoya Expressway Survey* by Ralph J. Watkins for the Ministry of Construction, Government of Japan (August 8, 1956, 188 pp.), and *Materials on The Shizuoka–Toyokawa Expressway Project* prepared for the International Bank for Reconstruction and Development, e.g., IV. *Materials on Toll Traffic and Economic Benefits*, Nihon Doro Kodan [Japan Highway Public Corporation (Tokyo, Japan, December 1964 (S. 39), A4 edition, 73 pp.]. For this difficult

problem, the old historical school-like *Treatise on Transport* did not work at all, and a new theory and method were indeed required.

On consideration of how much the pecuniary economic effects should be, for the payability/feasibility study of the Meishin Expressway, we were at that time facing the problem of what the amounts of the indirect economic effects ought to be, except for the effects of savings in running costs and reduction in transport time, which form the majority of the direct economic effects in popular thinking and are textbook-like.

For this, there are several antithetical concepts: (1) What is said to be indirect economic effects are intrinsically nothing but what is transferred from the direct effects, so it will not be able to add up to the direct effects. If this assertion is aggravated, then it turns out to be *perfect transfer theory*. (2) To the contrary, excepting the transferred indirect economic effects, there is an assertion that there are independently existing indirect economic effects apart from these. (3) Supposing the future demand function at the target period included all such various indirect effects, there also is an assertion that if only the direct effects have been estimated, there is no need to worry about the measurement problem of indirect effects.[1]

However it may be with a mathematical model, it is universally admitted that the estimation in advance of such future composite demand function will be extremely difficult. This is the great crux of the subject standing in our way before the measurement of economic effects of public investment.

This problem is explained first in Chap. 9 briefly, and in exposition of the points in dispute in the latter part of this preface, our intention of how to cope with it is taken up.

More definitively, we have put the root of analysis on the windfall-like effects brought about by the initial impacts of gigantic public investments, that is, the great downfall of (long-run, short-run) marginal costs.

For a start, a summary by chapter is given. First, in Chap. 4, there are the following examples of the (pure) indirect economic effects which are not the indirect effects transferred from the direct effects: (1) ease of traffic congestion on existing roads, (2) scale-enlargement of factories–warehouses, and (3) Marshallian external economies are enumerated.

In Chap. 5, especially, the Marshallian externality is explained. The concept will be further clarified in that "technological and marketable propagation-diffusion of the technological external economies" ought to give rise to the scale-enlargement of upstream industries (raw materials purchased, product selling, advertisements, craftsmen's training, etc.) which will be input materials to the industry concerned (for instance, bread production and selling) which enjoys directly the technological innovation effects of expressways, the repercussion effects of which also are received. Here, the basic process is shaped into a "propagation-diffusion basis."

[1] Kanemoto, Y., and K. Mera. 1985. *Regional Science and Urban Economics* 15: 343–363.

In Chap. 9, based on the market equilibrium model, the confirmation of the independent existence theory has been grounded on the discrepancy of the magnitude of the generation base vs. incidence base benefits and has attained the most important target of this volume by demonstrating the existence of the independent existence doctrine of the indirect economic effects.

In Chap. 10, based on the general equilibrium model, further generalization of the externality of technological propagation-diffusion can be attained.

The above forms the mainstream of this volume and has been treated systematically in Chap. 1, Sect. 1.4 (*No. 1*); in Chap. 4, Sect. 4.3 (*No. 2*); in Chap. 5, Sect. 5.1 (*No. 3*); and in Chap. 10, Sect. 10.2 (*No. 4*).

Another large stream is the measurement method on the individual economic effects (by item). This is not a large-scale econometrics model, nor is it a large-scale interregional input-output programming model of the second volume (by which we can only derive macro gross economic effects), but, rather, what is said to be the "World Bank Method," which we will show in Tables 1.1 and 1.2 in Chap. 1, in which the following items are included: running costs saving, transport time reduction, decrease of load-damaged (goods-holder's benefits), enlargement of market area, and relaxation of upper limits (capacity restriction) of transport lot (1- or 2-t vehicle → 20-t vehicle setup). This will have borne fruit in the scale-enlargement effects of the factory-warehouse and will also be revealed to be Marshallian economic effects.

We must make mention of one more fact that concerns the measurement of the time-saving evaluation rate of Chap. 2 and measurement of public pollution (noise) evaluation rate of Chaps. 6 and 7.

Tables 1.1 and 1.2 mentioned above show that these are measured in terms of physical units. The individual effects by item must be summed up to one scalar magnitude, that is, we must convert these effects to monetary terms and sum them up. For this purpose, we need a coefficient of conversion. Here, there is indispensable derivation work.

Chapter 3 is an easy elucidation of the perfect transfer theory of indirect effects, and Chap. 8 is the elucidation in numerical expression of the following formula:

$$\textit{Benefits in incidence base} > \textit{Benefits in generation base}$$

based on coordinate concepts such as generation base vs. incidence base as the time axis of measurement, remained vs. transferred, direct vs. indirect, etc. (of course, substantially, this theorem will be studied in Chaps. 9 and 10).

Finally, social costs and measurement of Chap. 6 are coordinate concepts of the social benefits which we have studied as the main research target, and they are posited and put together to form a counterpart to each other.

As explained above, a summary by chapter is given; then, from other points of view, we refer to the normative subjects at issue of three points, though with hesitation, which are as follows:

## Advocacy of the Independent Existence Theory of Indirect Economic Effects

The subject of our counterargument is the proposed model by which the future market demand function 40 or 50 years from now will be able to be forecast, in which all the direct and indirect effects will be included due to the impact of a huge public investment project like the Tokyo–Nagoya Expressway class that has turned up. If the model were valid, it would be an epoch-making proposal–proposition.

This might be shown by the example that the wording to spread the magnitude or social mission of the *indirect* economic effects of the Ministry of Land, Infrastructure, Transport and Tourism (formerly the Ministry of Construction) has disappeared these 30 years; nevertheless, there remain enormous public structures such as the Honshu–Shikoku Bridge Expressways (three), the long Enasan Tunnel (August 23, 1975), the second Tokyo–Nagoya (To-Mei) Expressway (April 14, 2012), and others.

This volume is what attempts to bring forth our counterargument against the model above. Being powerless against it is like a fly trying to bite a tortoise.

This is the method and measurement of economic effects (Sect. 9.2.1, 9.2.2) based on the market equilibrium model, with which we take great pains to carry out the existence proof of the equilibrium solution, with the measurement results obtained, and subsequently the analysis in Chap. 10.

By these dealings, the indirect economic effects that exist independently and differ from the transferred indirect effects are confirmed, and our target has been attained. These effects can be added to the direct effects.

As we thought, the indirect economic effects of huge projects to which our hand can reach ought to be taken hold of, optionally and gradually by the items of indirect effects respectively. Summed up these, the comprehensive indirect effects in this sense are obtained, which we contribute to public investment criteria.

It is our opinion that this scenario will be the most effective. We had better give up, for the time being, measuring all the items of indirect economic effects, e.g., indicated as *Items 1]–13]* in Sect. 11.5.2, at one stroke. The traffic congestion-easing effects described in Sect. 11.5.2, choosing just one item from 13 Items is a good example for the traffic congestion-easing effects *in big city*.

## Controversy Regarding Social Costs

As if the fundamental human rights of the French Revolution were being imitated, human rights of pedestrians are enhanced, fictitious human rights of which are proposed in terms of prohibitive costs, in order to protect citizens from noise pollution. (It seems that most citizens will not want such ridiculous rights. They will choose not such abstract rights, but, rather, the usual practical ones. Everyone will be aware of the additional tax burden.) It is our view that this is based on the

strong will of the proposer. Against this, the counterargument from the standpoint of practical sense is made.

If we would read accurately the assertions of both sides, they would be dispelled as a matter of course concerning what should be right. It is the way of the world that everything has gone wrong with us. (The greater part of the people such as citizens, the intelligentsia, and journalists will not read; they only praise.)

To get the people concerned to read, we had better make the results of our measurement of social costs *public* as a definitive edition in order to make them understand and support the truth. This is done in Chap. 6.

## Inquiry into and Restoration of Pecuniary = Monetary External Economies

Those who participate in public investment will hope to get a grasp of the comprehensive effects including the direct and indirect economic effects, with which to investigate public investment criteria thoroughly. Therefore, the indirect effects are indispensable for us.

The impacts of the project, however, are on the users as the technological direct effects only at first. A part or most part of the impact will come from the next stage as transferred indirect effects, transferred from one firm or consumer to another, one after the other.

Apart from this, going beneath the surface like water running underground at the beginning, with the impact at the same initial time, there are also indirect effects that will manifest themselves as Marshallian external economies *at a stage along the way* and will join in the transferring of the indirect effects mentioned above.

These are prevalent in the market economy, the economic society, as the sequence of pecuniary external economies, except the technological external economies at the first stage, that is, column $\alpha$ (see also columns $\beta, \gamma, \ldots$..) of Fig. 1.1 of 1.1).

When the initial impact propagates and diffuses and converges at the general equilibrium solution, there exist the effects expressed by the revised *price* $\times$ *quantity*, as the differences before and after the advent of impact, which are in a very small quantity at the unit level of generation of each effect and yet range across all goods and services and over whole regions.

The difficult problem, however, is left unsolved: that, if possible, we want to separate (a) what the effects due to any specific initial impact may drift to and (b) the others, at *the mouths of all streams*. If this is solved, all the problems of economic effects will be settled. The current mainstream of thought is that for a long time there has been no need to measure what once flows into the market economy.

Those like us, who take charge of public investment, however, would like to discriminate and pick up the so-called pecuniary external economies that flow in and are buried, without fail, in the market economy.

Pecuniary external economies are by no means vague, absurd, and abominable ones, but ought to exist clearly and with certainty, as mentioned above. This is rather a clear fact. This is what is referred to and dealt with in Sects. 9.2.2 and 11.4. It seems that we could get to the heart of the problem by tables and figures only. In this way, the three points above are treated mildly.

I have studied transport economics and related matters off and on for these 50 years. A deep sense of gratitude is felt for the Japan Highway Public Corporation (Economic Research Office) where I had been an investigator for about 10 years from 1961 or so, in an atmosphere like the "Research Office" of the South Manchuria Railway.

At that time, I was influenced by O. Eckstein, P.O. Steiner, S.A. Marglin, Julius Margolis, T. Scitovsky, et al. of the Water Resources Group of Harvard University; L.N. Moses (in the second volume) of Northwestern University; and J. Tinbergen, H.B. Chenery, H. Hotelling, et al. of Europe.

Here, I express my gratitude to those who guided me in a broad sense and to the Japan Highway Public Corporation, which provided me a "cradle." So, continued to the last line.

And, I express my gratitude to Mrs. Hatsumi Uchimura, one of the secretaries to professor Dr. Yoshiro Higano (the 43rd president of RSAI) for her laborious and painstaking personal computer input services of this volume's manuscript as side work except for her original secretary work. Likewise, I thank Mr. Tatsuya Shimatai (editorial room, Tokyo Branch Office, Sasaki Printing & Publishing Co.) from the bottom of my heart for his kindness and for his assistance with the tables, figures, and numerical formulas from their initial stage, with an editorial technical viewpoint. Lastly, I am deeply grateful to Mr. Yutaka Hirachi, publishing editor, Springer Japan KK, for his kindness; he guided an inexperienced writer like me considerately and merged, somehow, this manuscript to its present form as the first volume of the series according to the innovative basal principle from the stage of planning. And I also express my deep gratitude to Ms Misao Taguchi for her tireless assistance and for her help in arranging my manuscript. Finally I would like to thank the anonymous native-speaker referees who have checked my manuscript from beginning to end; without their kindness, my volume would not have been published. Their expert advice was invaluable, and I am full of gratitude. Thank you very much.

*Dedicated to the Japan Highway Public Corporation*

Professor Emeritus
University of Tsukuba
Tokyo
August 18, 2015

Hirotada Kohno

# Contents

# About the Author

**Hirotada Kohno** was born on August 18, 1932. He graduated from the Faculty of Economics, Kagawa University, in 1955. From September 1957 to October 1960, he served as a researcher at the Expressway Research Foundation of Japan. From November 1960 to March 1965, he served as a researcher at the former Japan Highway Public Corporation, Economic Research Office. In April 1965, he began studies of economic theory and economic history in the Ph.D. program at the Graduate School of Economics, the University of Tokyo, and in March 1971, he did Program Withdrawal with Satisfaction of Credit and Enrolment Requirements. From 1971 to 1977, H. Kohno worked for the Department of Business Administration, Yokohama National University, as an associate professor (but, lecturer for 1971 only). Later, until 1996, he worked for the Institute of Socio-Economic Planning, the University of Tsukuba, as a professor (an emeritus professor conferred). In 1994 and 2007, he was a member of the 3rd division (economics) course, at the Science Council of Japan (SCJ). There he held positions including secretary, vice-chief, and chief. From 2007 to the present, he has been a councilor of the Japan Science Support Foundation, a publicly incorporated foundation. From 1983 to 1992, H. Kohno was the president of the Japan Section of the Regional Science Association International (RSAI), where he had been a member since 1962. From 1999 to 2000, he was the president of the RSAI, and from 1992 to 1997, he was the chairman of the organizing committee of the 5th World Congress of the RSAI, held May 2–6, 1996, in Tokyo. In 2006, the RSAI established "The H. Kohno Award for Outstanding Service to the RSAI" in order to encourage excellent young scholars.

# Chapter 1
# Definition of Economic Effects, Necessity of Measurement, Prototype Model, and Externalities

In this chapter, we are investigating economic effects brought about by public investment, especially theory and measurement of indirect economic effects.

What will be the fine target for our study will be shown partly by the next passage by Dr. Jan Tinbergen (Aug. 1975, [21] p. 248):

> Comparing (13.19) and (14.1) we find an increase in national product of 30, or 10.7 percent. It is interesting again to compare this result with the decrease in transportation costs on the flows actually in existence under the initial conditions. Since transportation costs were $(T_{13} - 1)(V_{13} + V_{31})$ and at the new transportation coefficients $(T'_{13} - 1)(V_{13} + V_{31})$, the decrease is $(T_{13} - T'_{13})(V_{13} + V_{31})$, which appears to be 8. The "multiplier" to be applied to this figure in order to arrive at the exact consequences of the transportation improvement therefore amounts, in this example, to $30/8 = 3.8$.

Here is shown the so-called Tinbergen multiplier in which the indirect economic effects are 3.8 times as much as the direct economic effects. In this volume, going along with this guiding principle, but in a more modern framework, we intend to pursue our objective.

Hereafter, we use the terminology of "economic effects" the same as that of "social benefits." More precisely, we should say "indirect economic effects."

## 1.1 What Is Economic Effects or Social Benefits?

The transport investment as the public investment for the transport-related field is thought to be an external economies-generating installation system that may bring about social benefits to the constituent member (individuals and firms) of the national economy who will not necessarily be requested to pay the equivalent charges for received services, even if they are the bottleneck dissolutional type of investment or the preceding investment to the less developed regions ([1]).

Such social benefits ≒ the increase of total utilities are gotten hold of usually as direct effects plus indirect effects, technological external economies and



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marketable external economies, consumer's surplus plus producer's surplus (=the increase of total surplus), and/or pecuniary effects plus impecuniary effects, these roughly speaking.

That is, the social benefits which we aim at should be seized essentially in terms of utility, but it is very difficult to measure, so we used to do it in terms of surplus concept as proxy (the difficulty has been dissolved in Chap. 10, Appendix).

There is the standpoint, in conformity with J.E. Meade way of external economies definition [6], i.e., external economies = technological external economies only, which consequently prescribes our and surrounding custom not to be accurate. We, on the contrary, names economic effects brought about by public investment, above all, indirect economic effects to be both of technological and marketable (monetary<pecuniary>) external economies. That is, whether we should meet based on Meade way of definition or T. Scitovsky way of technological external economies and monetary external economies [20] in order to cope with economic effects brought about by public investment will differ, depending on how and on what kind of necessity we intend to use the obtained effects. Nothing has any absolute basis whose definition is true. That is, it depends on which definition is essential to the analysis (for the monetary external economies, see the elucidation of Sect. 9.2.3).

In this paper, under the pressure of necessity that we must grasp radically and accurately the *essence* and total amount of economic effects of *public* investment, the argument based on Scitovsky's definition will be evolved, not driving it out, but in the course of receiving it partially.

That is, in the case that we take hold of how much effects the public investments should bring about to the society and economy as a result and finally, it has been a commonly accepted view, so far, that the monetary external economies will be buried in the market economy, so there is no need to measure them.

However we must measure them accurately, in such a case that we must seize, numerically & not vaguely, how much economic effects have been formed by the newly constructed public transport facilities from the standpoint of the *public investment criteria* like us ([2], [4], [15]).

The effects of transport investment in the specific areas, that is, the construction of transport facilities, will be absorbed directly as technological external effects by the users like individuals and enterprises, and then the downward shift of cost functions of the enterprises concerned will result. The next stage is that the other enterprises who have dealings with the first-stage enterprise will receive the marketable (monetary) effects from the first enterprise (about these processes, see Fig. 1.1).

Such a process passes successively from one to the next and then finally will change the general equilibrium points of the whole economy. In the long run, this process will let the demand functions of related enterprises change considerably. Supposing that the general equilibrium point of the whole national economy will be expressed by *the goods and services quantity vector and the corresponding market price vector* (see [9], cited in 1.4.3.2), we can calculate their inner product, from which we deduct intermediate demand (input), resulting in the increase of the total

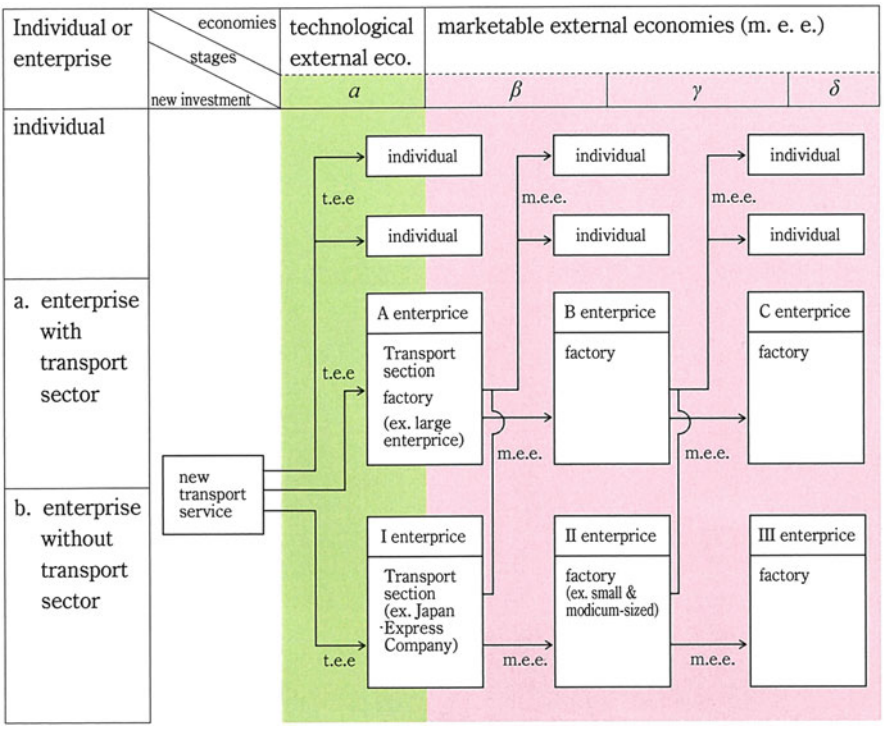


**Fig. 1.1** Propagation/diffusion process of economic effects brought about by new transport facilities—technological and monetary external economies. (*Source*: Kohno [1], p. 208)

value-added of the whole national economy in national income accounting. It is supposed that the equilibrium point of the whole economy will be expressed by the one amount as a scalar.

Now, what are the economic effects of transport investment? It will be defined that it is the present value of time series of comparative statics-like differences over the time horizon (i.e., by year) of the amount of value-added as the monetary expression of general equilibrium point of the total national economy, *in case* of the advent of our transport facilities, *or in no case* subject to the other various social overhead capital levels given (provided that there is no private investment induced by this transport investment in the intermediate stage). That is, it is seized by the time series obtained by applying the trend growth rate to the comparative statics-like value-added difference per year ([9], p. 276).

Again, if this is comparison of two points between before and after the construction of transport facilities, anyway it becomes comparative statics analysis.

If there is the private investment induced by the initial transport investment in the intermediate stage, this definition of economic effects will be altered to be "present value of time series of comparative dynamics-like difference." The related analysis to this is done in Chap. 5.

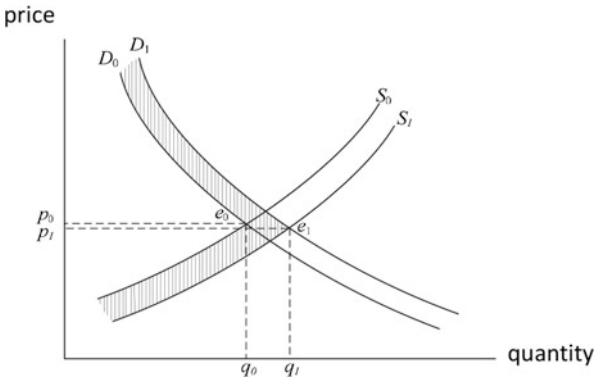


**Fig. 1.2** Increase of gross surplus
Notes: (1) $D_1, D_2$ and $S_0, S_1$ show demand curve and supply curve of the transport services for the whole market, which is not the demand for the transport facilities themselves.
(2) The shift of demand curve will fall behind compared to that of supply curve. For details, see the explanation of Fig. 9.1

The measurement method of economic effects shown by the above definition is called with and without comparison method ([19], p. 10, 16).

If we express such economic effects in terms of partial micro analysis by the gross surplus notion, it will be what are put into the present value and summed up to arrive at the total of both the increase of supplier's surplus and the increase of demander's surplus by year (the surplus such as the shaded area of Fig. 1.2 is formed annually) and by goods (by enterprise) over the time horizon (base period: $t = 0$). Let such an increase of total surplus be $b_{it}$($i$ *goods,* $i = 1, \ldots, m$*; and* $t = 1, \ldots, n$) and social discount rate be $\pi$, then economic effects here are grasped to be:

$$\sum_{i=1}^{m} \sum_{t=1}^{n} \frac{b_i}{(1+\pi)^t}. \tag{1.1}$$

However, the formation of demander's surplus will be done later compared to that of supplier's surplus, taken with time lag.

## 1.2 Necessity of Indirect Economic Effects Measurement

### *1.2.1 Intended External Economies Generating Installational Structure*

In the case that the national project or globally ultra-gigantic project will be constructed and utilized, we intend to measure numerically its economic effects,

which will exist in the various spreading forms, direct and indirect and propagational/diffusional [17].

The national project or ultra-gigantic project must be financed, almost without exception, taking the form of public investment in terms of *flow* and the construction of public facilities and social infrastructure in terms of *stock* (not the private ones) owing to the huge and long-ranged demand of investment fund.

In the case that we should construct public facilities with public funds, though not quite satisfactorily, our self-supporting accounting system:

$$\text{charge revenues} \geq \text{capital costs} + \text{management costs}$$

will be satisfied; however the benefits brought about by this public facilities will not be equal to the charge revenues (toll charge revenues). About various services supplied even by the private enterprise, the following inequality:

$$\text{benefits}\,(\text{consumer surplus}) \geq \text{payed equivalent}$$

will always come into existence. How much more must the social benefits brought about by public facilities be enormous, compared with charges/rates/fees as equivalents payed nominally in the capacity of beneficiary (user) burden (as to this two sections, hereafter, based on [4], pp. 1–3).

The additional benefits received more than the equivalent such a way can be taken very roughly speaking as:

$$\text{consumer surplus or/and external economies.}$$

Social significance of the ultra-huge project will lie in that the public authorities concerned will construct such projects so that they should let citizens (consumers) and enterprises enjoy, *intentionally*, such external economies.

It will be thought that we will be able to create something valuable (i.e., social benefits) out of nothing by investing the public funds which are composed by putting together relatively small public funds as scarce resources to the public projects mentioned above, based on the *social marginal opportunity cost criterion*.

### 1.2.2 Discrepancy of Private Profitability and Social Usefulness

That is, if only the public facilities are created, then they have satisfactory "social usefulness." But, in the case of the private goods, if only there is a private profitability, i.e., the positive profit is formed, then we can say that it has a social usefulness. However, in the case of public services, moreover, even if it has no any private profitability, that is, the positive profit may not be formed and resulted in red figures, there are many cases in which they have the social usefulness.

As mentioned above, the fact that there is discrepancy between the private profitability and social usefulness means that the management and installation don't work sufficiently, in which the equivalent prices to the social benefits brought about by public facilities should be set and the part of these benefits should be returned to the public authorities concerned; consequently the charged revenues shown by the next inequality:

$$[\text{charged revenues} \geq \text{necessary costs}]$$

aren't guaranteed. However, even in such a case, the truth is that the social benefits, which may not be taken hold of numerically, will propagate, diffuse, and spread in every corner of the society, and these will bear fruit to the citizens and enterprises.

These are said to be indirect economic effects in incidence base. So, as long as this underground water vein exists in our society, irrespective of the level of private profitability (of public facilities), there will be social usefulness of public facilities, more often than not (Negishi [13], pp. 29–33; for details, [12]).

### *1.2.3 Necessity of Economic Effects Measurement of the Public Investment*

As it is, the social benefits, which will be brought about by public investments, above all, the expressway network, and exceed the charge revenues as equivalent price, will be different from the benefits of private goods such as tangerine, apple, videodisc, etc., and have the specific characteristic of being "nonmarketable." On the other hand, the private goods, unless necessaries, is that the demand curve to it may nearly be horizontal, and we will be able to take no notice of consumer' surplus, as the first approximation.

In this situation, the social gross benefits are nearly equal to the amount ($=$ quantity $\times$ market price), that is, as the marginal benefit valuation rate is nearly equal to the market price, we can use the market price as the proxy of marginal benefit valuation rate; if the public authorities concerned sell tangerine, they needn't measure afresh the social benefits (economic effects) of tangerine.

But, as to nonmarketable service goods, this alters the case. Nothing exists relating to current indexes. Therefore, the public authorities concerned must formally measure the social benefits numerically. This is the *measurement problem* of the economic effects brought about by the public investment.

Especially in the case where services of public utility works have the property of necessaries, as its demand curve comes to be sharp and forms enormous consumer surplus, we must not infer the truth by the superficial profitability only.

In a feasibility study on social benefits, economic effects are taken hold of as:

$$\text{Social Benefits} \fallingdotseq \text{Direct Economic effects} + \text{Indirect Economic Effects}.$$

As the first approximation, it is such a case that we will be able to regard the direct economic effects as corresponding (proportional) to the private profitability mentioned above.

### 1.2.4 Importance of Indirect Economic Effects and Necessity of Their Measurement

However, the ratio of direct effects to indirect effects is not fixed, depending on projects (the ratio of above the surface of the sea vs. below the surface of the sea like the iceberg is known to be 1:9, but, things won't turn out the same as this case). Therefore, to draw up our public investment criteria based on the private profitability or direct economic effects only does not be allowed essentially absolutely. Here is the necessity of measurement of indirect economic effects brought about by the public investment.

### 1.2.5 Enormousness of Indirect Economic Effects Compared To Direct Ones

The enormousness and ratio of indirect economic effects compared to direct economic effects vary by the type of transport facilities, by region, and by time, but it becomes generally known from old that the indirect economic effects are enormous compared to the direct ones beyond our expectations. The *Tinbergen multiplier* was shown to be 3.8 times as large as direct effects (see the opening paragraph).

As shown by this example, the economic effects of the newly constructed transport facilities will be not only direct effects indicated by the conventional saving benefits of running costs, saving benefits of the time required, etc. but also indirect economic effects, which will be formed through the following process: in the first place, the technological innovation by the newly constructed transport facilities will give rise to the downward shift of marginal cost curve of the individual direct user and, next, the direct effects by which will induce the following trigger effects—the decrease of market price of the goods concerned; the increase of equilibrium quantities; propagating, diffusing, spreading, or according to circumstances; and amplifying and expanding to the whole market—will continue until the readjustment comes to an end over the whole economy; thus the indirect economic effects of ten or more tens times as large as that of the direct ones will be able to be formed.