

New Frontiers in Regional Science: Asian Perspectives 1

Hirota Kohno

# Economic Effects of Public Investment

An Emphasis on Marshallian and  
Monetary External Economies

 Springer

# **New Frontiers in Regional Science: Asian Perspectives**

## **Volume 1**

### **Editor in Chief**

Yoshiro Higano, University of Tsukuba

### **Managing Editors**

Makoto Tawada (General Managing Editor), Aichi Gakuin University

Kiyoko Hagihara, Bukkyo University

Lily Kiminami, Niigata University

### **Editorial Board**

Sakai Yasuhiro (Advisor Chief Japan), Shiga University

Yasuhide Okuyama, University of Kitakyushu

Zheng Wang, Chinese Academy of Sciences

Yuzuru Miyata, Toyohashi University of Technology

Hiroyuki Shibusawa, Toyohashi University of Technology

Saburo Saito, Fukuoka University

Makoto Okamura, Hiroshima University

Moriki Hosoe, Kumamoto Gakuen University

Budy Prasetyo Resosudarmo, Crawford School of Public Policy, ANU

Shin-Kun Peng, Academia Sinica

Geoffrey John Dennis Hewings, University of Illinois

Euijune Kim, Seoul National University

Srijit Mishra, Indira Gandhi Institute of Development Research

Amitrajeet A. Batabyal, Rochester Institute of Technology

Yizhi Wang, Shanghai Academy of Social Sciences

Daniel Shefer, Technion - Israel Institute of Technology

Akira Kiminami, The University of Tokyo

### **Advisory Board**

Peter Nijkamp (Chair, Ex Officio Member of Editorial Board), Tinbergen Institute

Rachel S. Franklin, Brown University

Mark D. Partridge, Ohio State University

Jacques Poot, University of Waikato

Aura Reggiani, University of Bologna

## **New Frontiers in Regional Science: Asian Perspectives**

This series is a constellation of works by scholars in the field of regional science and in related disciplines specifically focusing on dynamism in Asia.

Asia is the most dynamic part of the world. Japan, Korea, Taiwan, and Singapore experienced rapid and miracle economic growth in the 1970s. Malaysia, Indonesia, and Thailand followed in the 1980s. China, India, and Vietnam are now rising countries in Asia and are even leading the world economy. Due to their rapid economic development and growth, Asian countries continue to face a variety of urgent issues including regional and institutional unbalanced growth, environmental problems, poverty amidst prosperity, an ageing society, the collapse of the bubble economy, and deflation, among others.

Asian countries are diversified as they have their own cultural, historical, and geographical as well as political conditions. Due to this fact, scholars specializing in regional science as an inter- and multi-discipline have taken leading roles in providing mitigating policy proposals based on robust interdisciplinary analysis of multifaceted regional issues and subjects in Asia. This series not only will present unique research results from Asia that are unfamiliar in other parts of the world because of language barriers, but also will publish advanced research results from those regions that have focused on regional and urban issues in Asia from different perspectives.

The series aims to expand the frontiers of regional science through diffusion of intrinsically developed and advanced modern regional science methodologies in Asia and other areas of the world. Readers will be inspired to realize that regional and urban issues in the world are so vast that their established methodologies still have space for development and refinement, and to understand the importance of the interdisciplinary and multidisciplinary approach that is inherent in regional science for analyzing and resolving urgent regional and urban issues in Asia.

Topics under consideration in this series include the theory of social cost and benefit analysis and criteria of public investments, socioeconomic vulnerability against disasters, food security and policy, agro-food systems in China, industrial clustering in Asia, comprehensive management of water environment and resources in a river basin, the international trade bloc and food security, migration and labor market in Asia, land policy and local property tax, information and communication technology planning, consumer “shop-around” movements, and regeneration of downtowns, among others.

Researchers who are interested in publishing their books in this Series should obtain a proposal form from Yoshiro Higano (Editor in Chief, [higano@jrsai.envr.tsukuba.ac.jp](mailto:higano@jrsai.envr.tsukuba.ac.jp)) and return the completed form to him.

More information about this series at <http://www.springer.com/series/13039>

Hirota da Kohno

# Economic Effects of Public Investment

An Emphasis on Marshallian and Monetary External Economies

 Springer

Hirotsada Kohno  
Professor Emeritus  
University of Tsukuba  
Tsukuba  
Japan

ISSN 2199-5974                      ISSN 2199-5982 (electronic)  
New Frontiers in Regional Science: Asian Perspectives  
ISBN 978-4-431-55223-9              ISBN 978-4-431-55224-6 (eBook)  
DOI 10.1007/978-4-431-55224-6

Library of Congress Control Number: 2016934049

© Springer Japan 2016

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature  
The registered company is Springer Japan KK

# 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.<sup>1</sup>

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.”

---

<sup>1</sup> 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  $\beta, \gamma, \dots$ ) 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

Hirotsada Kohno

# Contents

<b>1</b>	<b>Definition of Economic Effects, Necessity of Measurement, Prototype Model, and Externalities . . . . .</b>	<b>1</b>
1.1	What Is Economic Effects or Social Benefits? . . . . .	1
1.2	Necessity of Indirect Economic Effects Measurement . . . . .	4
1.2.1	Intended External Economies Generating Installational Structure . . . . .	4
1.2.2	Discrepancy of Private Profitability and Social Usefulness . . . . .	5
1.2.3	Necessity of Economic Effects Measurement of the Public Investment . . . . .	6
1.2.4	Importance of Indirect Economic Effects and Necessity of Their Measurement . . . . .	7
1.2.5	Enormousness of Indirect Economic Effects Compared To Direct Ones . . . . .	7
1.3	Prototype Model for Measurement Method of Individual Economic Effects . . . . .	8
1.3.1	Prototype Model . . . . .	9
1.3.1.1	Direct Economic Effects . . . . .	10
1.3.1.1.1	Saving Benefits of Running Costs . . . . .	10
1.3.1.1.2	Saving of Transport Time . . . . .	12
1.3.1.2	Superficial Definition of Indirect Effects as a Complementary Set . . . . .	12
1.3.2	Multilayered and Causal Relationship Among Items of Individual Economic Effects . . . . .	13
1.4	Technological Externality and Monetary Externality: Number 1 . . . . .	15
1.4.1	Basic Concept of Monetary Externality . . . . .	15

- 1.4.2 An Explanation on Restoration of Development Profits . . . . . 16
- 1.4.3 Special Treatise on Indirect Economic Effects Measurement and Their Enormous Magnitude . . . . . 18
  - 1.4.3.1 Special Treatise on Public Utility . . . . . 18
  - 1.4.3.2 Indirect Effects Measurement Method Based on Ultimate Indicator of Changes of Profits = Product  $\times$  Price in the General Equilibrium and Taking Hold of Enormous Magnitude . . . . . 18
  - 1.4.3.3 Brief Review on Monetary External Economies . . . . . 21
- References . . . . . 21
- 2 Time-Saved Evaluation and Social Discount Rate . . . . . 23**
  - 2.1 Time-Saved Evaluation . . . . . 23
    - 2.1.1 Measuring Method Taking Hold of Trade-Offs Between the Drivers’ Speed Selection and His Driving Time Value . . . . . 24
      - 2.1.1.1 Herbert Mohring’s Model . . . . . 24
      - 2.1.1.2 Application of Mohring Model to Metropolitan Expressway of Japan . . . . . 27
    - 2.1.2 Measuring Method of Time Value Through the Medium of the Ratio of Traffic Assignment . . . . . 29
  - 2.2 Social Discount Rate . . . . . 32
    - 2.2.1 Several Social Discount Rates . . . . . 33
    - 2.2.2 Eckstein’s Social Discount Rate Model . . . . . 34
  - References . . . . . 38
- 3 Perfect Transfer Theory of Indirect Economic Effects Formation: Based on the Generation Base vs. Incidence Base . . . . . 41**
  - 3.1 Transport Service Demand · Supply Function of Individual Firm . . . . . 41
  - 3.2 Gross Surplus Originated from the Transport Service of Individual Firm (Firm A) . . . . . 43
  - 3.3 Demand Function and Supply Function to and of the “Strawberry” Products of Firm A . . . . . 45
  - 3.4 Market Demand Curve and the Shift of Market Supply Curve of s Goods . . . . . 46
  - 3.5 Direct Effects of Incidence Base of Firm A . . . . . 47
  - 3.6 Indirect Economic Effects Spreading to Firm B, Firm C, etc. . . . . 48
  - 3.7 Transferred Indirect Economic Effects in Incidence Base . . . . . 50
  - 3.8 Numerical Expression of the Perfect Transfer Theory . . . . . 51
  - 3.9 Summation of Economic Effects by Item·by Period (Incidence Base) . . . . . 54
  - References . . . . . 55

**4 Independent Existence Theory Forming Indirect Effects and Its Three Examples: Congestion Easing, Scale Enlargement of Factory-Warehouse, and Marshallian External Economies . . . . .** 57

4.1 Congestion-Easing Effects on the Existing (Competitive) Highway . . . . . 57

4.2 Scale-Enlargement Effects of Factory-Warehouse . . . . . 58

4.3 Marshallian External Economies: Number 2 . . . . . 61

4.3.1 Transition Process of Temporary Equilibrium of Representative Firm Due to Marshallian External Economies ( $p_I \rightarrow p_A$ ) . . . . . 61

4.3.2 Formation of Monetary External Economies of Price Decline ( $p_I \rightarrow p_A$ ) Due to Marshallian Technological External Economies . . . . . 63

References . . . . . 64

**5 Formation Process of Marshallian External Economies: Number 3—Technological and Marketable Propagation/Diffusion of the “Technological External Economies” . . . . .** 65

5.1 Marshallian External Economies: In the Case That Has the Technological-Marketable External Economies Induced at the Stage on the Way . . . . . 65

5.2 Scale-Enlargement Effects of Factory . . . . . 70

5.3 Enormousness of the Technological Propagation/Diffusion: Not Always Being Attenuated, But . . . . . 70

5.3.1 Enormousness of the Technological Propagation/Diffusion of Technological External Economies: Parallel-Concurrently Occurred Formation Induced at the Stage on the Way . . . . . 70

5.3.2 Prehistory of “Nonmarketable Propagation/Diffusion of Technological External Economies” . . . . . 71

5.3.3 Paralleled Frequently Concurrent Propagation/Diffusion Process Induced at the Stage on the Way: Not Necessarily Attenuated Diffusion But Possibly Amplified Enlargement . . . . . 72

5.4 Concluding Remarks—Led to the “Propagation/Diffusion Basis” . . . . . 74

5.4.1 Devising the Propagation/Diffusion Basis . . . . . 74

5.4.2 Scale-Enlargement Effects of Factory-Warehouse: Existence Recognized Toward Measurement and Utilization . . . . . 75

5.4.3 On Amplified External Economies . . . . . 77

References . . . . . 78

- 6 Social Costs and the Measurement . . . . . 79**
- 6.1 Definitions of Social Costs . . . . . 79
  - 6.1.1 Various Definitions of Social Costs . . . . . 79
    - 6.1.1.1 “National Economic Total Costs” View . . . . . 80
    - 6.1.1.2 “Loss Deviated from the Optimum Organization” View . . . . . 81
    - 6.1.1.3 “Nonmarketable Burden by the Third-Party” View . . . . . 81
    - 6.1.1.4 “Environmental Damage Reduction Costs” View . . . . . 81
  - 6.1.2 Illustration by Diagram . . . . . 82
- 6.2 Social Cost Controversy of Auto . . . . . 85
  - 6.2.1 Former Part: Offense and Defense of 70 Thousand vs. 7 Thousand Yen per Vehicle per Year of Auto . . . . . 85
  - 6.2.2 Latter Part: Hypothetical Figures of 2 Million Yen More or Less per Auto per Year . . . . . 91
  - 6.2.3 Undercurrent in the Deep Structure of the Controversy on the Social Costs of Auto . . . . . 94
- 6.3 Measurement of Social Costs—Bird’s-Eye View Extracts from the Definitive Edition . . . . . 96
  - 6.3.1 General Presupposition . . . . . 96
    - 6.3.1.1 Fundamental Principle of Measurement of Noise Reduction Costs . . . . . 97
    - 6.3.1.2 Fundamental Principle of Measurement of Costs Coping with Accidents . . . . . 98
    - 6.3.1.3 Selection of the Targeted Area . . . . . 98
    - 6.3.1.4 Targeted Highway . . . . . 98
    - 6.3.1.5 Areal Classification of Roadside . . . . . 99
    - 6.3.1.6 Flow Chart of Noise Reduction Costs/ Accident Reduction Costs . . . . . 99
  - 6.3.2 Measurement of Noise Reduction Costs . . . . . 99
    - 6.3.2.1 Target Value for the Environmental Preservation . . . . . 99
    - 6.3.2.2 Various Measures for Noise Reduction . . . . . 101
    - 6.3.2.3 Combination of Noise-Exterminating Steps . . . . . 101
    - 6.3.2.4 Supposition of Reduction Work Quantity by Noise Reduction Measure . . . . . 102
    - 6.3.2.5 Unit Price per Kilometer of Noise Reduction Costs . . . . . 103
    - 6.3.2.6 Total Road Length by Noise Rank . . . . . 104
    - 6.3.2.7 Noise Reduction Costs by Area . . . . . 105
    - 6.3.2.8 Noise Reduction Costs by Item . . . . . 106
    - 6.3.2.9 Noise Reduction Costs per 1 Running Vehicle/Kilometer . . . . . 106

6.3.3	Measurement of Accident Reduction Costs . . . . .	106
6.3.3.1	Targeted Highway . . . . .	106
6.3.3.2	Sidewalk Installation Costs . . . . .	107
6.3.3.3	The Others' Accident Reduction Costs . . . . .	107
6.3.3.4	Estimated Accident Reduction Costs . . . . .	108
6.3.4	A Consideration on the Measured Results of Social Costs . . . . .	108
6.3.4.1	Road Length in Need of Environmental Reduction Measures . . . . .	108
	(i) Ratio of road length where the noise being more than 55 phon (1) to road length more than four lanes (6): (1)/(6) . . . . .	108
	(ii) Ratio of road length (1) to road length more than prefectural road (7): (1)/(7) . . . . .	110
	(iii) Ratio of road length more than 60 phon (2) to the (7): (2)/(7) . . . . .	110
	(iv) Ratio of road length in need of accident reduction measures (4) to the (7): (4)/(7) . . . . .	110
	(v) Ratio of road length in need of accident reduction measures (5) to the whole road length of higher level than trunk municipal road (8): (5)/(8) . . . . .	111
6.3.4.2	Magnitude of Social Costs (Environmental Reduction Costs) . . . . .	111
6.3.4.3	Conclusion: Social Costs per 1 Auto Vehicle per Year . . . . .	112
6.3.4.4	Data for Comparative Study . . . . .	112
6.4	Closing Comments . . . . .	115
6.4.1	Empirical Analysis of Political Economics-Like Subject . . . . .	115
6.4.2	Uzawa Model and the Measurement Result of Social Costs as Definitive Version . . . . .	115
6.4.3	Meaningfulness of the Measurement Result of Social Costs as Definitive Version . . . . .	116
	References . . . . .	116
7	<b>Measurement of Evaluation Rate of Public Pollution (Noise) . . . . .</b>	<b>119</b>
7.1	Measurement of Noise Evaluation Rate Using Multiattributed Utility Theory . . . . .	119
7.1.1	Necessity of Comprehensive Evaluation . . . . .	119
7.1.2	Theory of Multiattribute Utility Function . . . . .	120



- 7.1.3 Evaluation Method of Multiattribute Utility Function . . . 123
  - 7.1.3.1 Verifying the Preferentially Independent . . . 124
  - 7.1.3.2 Verifying the Utility Independent . . . . . 125
  - 7.1.3.3 Ordering of the Scaling Constants . . . . . 126
  - 7.1.3.4 Evaluating the Scaling Constants of  $k_i$  . . . . . 127
  - 7.1.3.5 Evaluation of the Single Attribute Utility Function  $U_i(x_i)$  . . . . . 129
  - 7.1.3.6 Identification of Whether the Multiattribute Utility Function  $U_x$  Will Be Additive or Multiplicative . . . . . 130
  - 7.1.3.7 Evaluation of the Scaling Constants  $k$  in Case of Being Multiplicative . . . . . 131
- 7.1.4 Measurement of Evaluation Rates of Public Pollution (Noise) and the Commuting Time . . . . . 132
- 7.1.5 Appraisal of the Multiattribute Utility Function in Order to Measure the Evaluation Rates of Public Pollution and the Commuting Time . . . . . 133
  - Design of Questionnaire Sheets for Evaluation of Multiattribute Utility Function . . . . . 133
    1. Attributes, its unit of measurement, and the permissible range of data . . . . . 133
    2. Serial questions for evaluation of the multiattribute utility function . . . . . 133
      - (1) Serial questions for verification of preferentially independent . . . . . 133
      - (2) Serial questions for verification of utility independent . . . . . 134
      - (3) Serial questions for evaluating the scaling constants . . . . . 135
      - (4) Question for the identification of functional form of the multiattribute utility function . . . . . 136
- 7.1.6 Interviewee A's Measurement Results of Multiattribute Utility Function and the Evaluation Rates of Public Pollution and Commuting Time . . . . . 137
  - 7.1.6.1 Verified Results of the Preferentially Independent . . . . . 138
  - 7.1.6.2 Verified Results of the Utility Independent . . . 139
  - 7.1.6.3 Evaluated Results of the Scaling Constants  $k_i$  . . . . . 141
  - 7.1.6.4 Identified Results of Functional Form of Multiattribute Utility Function and the Accomplishment of Evaluation Rates as Targeted Objectives . . . . . 142
- 7.1.7 Problems Left . . . . . 143

7.2	Theory and Measurement of Pollution Evaluation Rate . . . . .	144
7.2.1	At the Beginning . . . . .	144
7.2.2	Measurement Results of Public Noise Evaluation Rate . . . . .	145
7.2.2.1	Measurement Results of Public Pollution Evaluation Rate by Cost Approach . . . . .	146
7.2.2.2	Measurement Results of Evaluation Rate of Public Pollution by Surplus Approach . . . . .	148
7.2.3	Closing Comments . . . . .	151
7.2.3.1	At the End: For Section 7.2 . . . . .	151
7.2.3.2	Closing Comments: For Section 7.1 . . . . .	152
7.2.3.3	Orientating at This Stage to the Problems Left: For Sections 7.1 and 7.2 . . . . .	153
	References . . . . .	153
<b>8</b>	<b>Criteria of Benefits Valuation—Remained vs. Transferred, and Generation Base vs. Incidence Base . . . . .</b>	<b>155</b>
8.1	Indirects Effects (Benefits) . . . . .	155
8.1.1	Toward Indirect Effects . . . . .	155
8.1.2	Theory of Indirect Effects . . . . .	156
8.2	Criteria of Benefits Valuation . . . . .	158
	References . . . . .	160
<b>9</b>	<b>Verification of Independent Existence Theory Depended on the Market Equilibrium Model: Based on the Great Discrepancy of the Benefits in Generation Base vs. the Benefits in Incidence Base . . . . .</b>	<b>161</b>
9.1	Construction of Computable Equilibrium Model . . . . .	161
9.1.1	Subject for Study . . . . .	161
9.1.2	Abstract of the Economy . . . . .	162
9.1.3	Interindustrial Input-Output Structure and the Production Technology of the Firm . . . . .	163
9.1.4	Utility Function of the Household . . . . .	164
9.1.5	Producer Equilibrium at Positive Market Prices and Wage Rates . . . . .	166
	Simple One Producer's Model A)—from Eq. 9.15 to Eq. 9.23 . . . . .	166
	M Kinds of Producers' Model B) ( $i = 1, 2, \dots, M$ ) . . . . .	168
	Submatrix Model Approach Where the Zero Input Column or Row Does be Excluded C) . . . . .	168
	Addendum . . . . .	169
	1) Submatrix Model Where the Column or Row Vector(s) Including Zero Element Will Be Excluded . . . . .	169
	2) Calculation of Inverse Matrix . . . . .	171

9.1.6	Household Equilibrium . . . . .	174
9.1.7	Market Equilibrium . . . . .	174
9.1.8	Properties of the Producer Equilibrium . . . . .	176
	Addendum . . . . .	181
	1) From Eqs. (9.48''), (9.49'') to (9.57) . . . . .	181
	2) From Eqs. (9.47-1) to (9.48') and (9.49') . . . . .	182
	3) Derivation of the Relevant Identities . . . . .	182
	4) Expansion of 3rd and 4th Terms of (9.49) . . . . .	184
	5) Derivation of 3rd and 4th terms of (9.49) being identical to 3rd and 4th terms of (9.49'') . . . . .	184
	(1) Expansion of Eq. (9.49) . . . . .	185
	(2) Expansion of Eq. (9.49'') . . . . .	186
9.1.9	Solution for the Market Equilibrium . . . . .	186
	Addendum . . . . .	190
	1) Derivation of $p_r Y_r = \beta_r^y \sigma_r$ (9.63) . . . . .	190
	2) Derivation of $\log \beta_r^y = \log \beta_{ir}^x - \log \alpha_{ir}$ (9.73) . . . . .	195
	3) Contraction of Market Equilibrium (9.69) to (9.70) . . . . .	196
	4) Derivation of $B_{11}^i = 1/\mu_i > (9.83)$ . . . . .	201
	(1) Matrix of Basis Data (Fig. 9.1) . . . . .	201
	(2) Subsidiary Definitions . . . . .	201
	(3) Inverse Matrix of Basis Data Matrix . . . . .	202
	(4) Toward Calculation of Inverse Matrix Elements Using (2) above . . . . .	203
	(5) The 1st row, 1st column, & off-diagonal of Fig. 9.1 . . . . .	204
	(6) Derivation of Eqs. (9.83) and (9.84) using (1)–(5) above just derived . . . . .	205
	(7) Derivation of $B_{1,j+2} = -E_{ji} \alpha_{ji} / \mu_i$ $\leq 0$ ( $j = 1, 2, \dots, M$ ) (9.84) . . . . .	206
9.1.10	Stability of the Equilibrium . . . . .	207
9.1.11	Visualization of Circulatory System of Industrial Structure . . . . .	208
9.1.12	Characteristic on Measurement of This Model . . . . .	209
	9.1.12.1 General Model Allowable for Zero Inputs . . . . .	209
	9.1.12.2 Necessity of Solutions Being Existent . . . . .	210
9.2	Theory of Indirect Economic Effects . . . . .	211
9.2.1	Measuring Theory of Indirect Economic Effects . . . . .	211
9.2.2	Expatiation on the Measuring of Theory of Indirect Economic Effects . . . . .	215
	Coverage and Degree of the Partial Equilibrium . . . . .	220
9.2.3	Monetary External Economies and the Marshallian External Economies . . . . .	223

9.3 Numerical Illustration . . . . . 224

9.4 At the End of This Chapter . . . . . 226

Appendix: Result of Simulation . . . . . 228

    [Model I (M = 4)] . . . . . 228

    [Model II (M = 5)] . . . . . 229

    [Model III (M = 6)] . . . . . 231

References . . . . . 232

**10 Generalization of Technological Propagation/Diffusion Externalities Based on the General Equilibrium Model of Formation Process of Marshallian External Economies: Number 4 . . . . . 235**

10.1 Study Stream So Far and Its Characteristic . . . . . 235

    10.1.1 Study Stream Property So Far . . . . . 235

    10.1.2 Main Subject of This Chapter: Development of Marshallian External Economies . . . . . 236

10.2 Decentralized Model . . . . . 236

    10.2.1 Behavior of Enterprise . . . . . 236

    10.2.2 Behavior of the Household . . . . . 238

    10.2.3 External Economies of the Industrial Scale Enlargement (Marshallian Externality) . . . . . 239

    10.2.4 Propagational/Diffusional Effects of Marshallian Type of Externality: Number 4 . . . . . 239

    10.2.5 Visualization of the Propagating–Diffusing Effects . . . . . 243

10.3 Simulation Cases . . . . . 244

    1. Specialization of the project impact . . . . . 244

    2. Industrial structure . . . . . 245

    3. (Setting up of parameters . . . . . 245

        <1>Model 1 . . . . . 245

            (a) Behavior of the representative enterprise . . . . . 245

            (b) Behavior of the household . . . . . 246

            (c) Externality . . . . . 246

            (d) Technological change owing to the implement of project . . . . . 247

        <2>Model 2 . . . . . 247

            (e) Technological change due to the implementation of project . . . . . 247

10.4 Results of Simulations . . . . . 248

10.5 Closing Comments . . . . . 250

Appendix: Policy Model for the Proof of Existence of Pure Indirect Economic Effects—Generation Base vs. Incidence Base Criteria . . . . . 251

    A1. Definition of Benefits . . . . . 251

        1. Logarithmic linear type utility function . . . . . 251

        2. Consumer surplus . . . . . 251

A2. Benefits of Incidence Base Criterion and Those of Generation Base Criterion . . . . .	252
1. Benefits of incidence base criterion . . . . .	252
2. Benefits of the generation base criteria . . . . .	252
(i) Prior to the implement of project . . . . .	252
(ii) Implement of the project . . . . .	252
(iii) Influence posterior to the implement of project in terms of the benefits in generation base . . . . .	252
References . . . . .	255
<b>11 Closing Paragraphs—On the Occasion of Closing This Volume: Economic Effects Theory and Measurement . . . . .</b>	<b>257</b>
11.1 Emphasis Placed on Marshallian External Economies . . . . .	257
11.2 Tinbergen's Indirect Economic Effects Measurement Method and Its Succession . . . . .	261
11.3 Problem Left Unfinished: Influence (Measurement) of the Transport System Innovation to the Scale Enlargement of Factories and Warehouses . . . . .	263
11.4 Pecuniary External Economies: Revisited . . . . .	264
11.5 Actual Measurement of Indirect Economic Effects . . . . .	270
11.5.1 Measurement of Direct Economic Effects . . . . .	270
11.5.1.1 Measurement by Traditional Method . . . . .	270
11.5.1.2 Measurement by Market Equilibrium Model . . . . .	270
11.5.2 Measurement of Indirect Economic Effects . . . . .	270
1) Traffic congestion-easing effects . . . . .	270
2) Enlargement of market area . . . . .	271
3) Dispersion of city population . . . . .	271
4) Rationalization of distribution industry . . . . .	271
5) Industrial development . . . . .	271
6) Resource development . . . . .	271
7) Rationalization of production . . . . .	271
8) Rationalization of transport planning . . . . .	271
9) Decrease of uncertainty . . . . .	271
10) Decrease of traffic accident rate . . . . .	271
11) Decrease of load-damaged (= owner (of the goods) benefits) . . . . .	271
12) Scale enlargement of factories and warehouses (relaxing upper-limit capacity restriction of transport lot) . . . . .	271
13) Marshallian external economies (=scale enlargement of industry), etc. . . . .	271

11.6	Editorial Aim of This Volume and the Source of the Study . . . .	273
11.6.1	Editorial Principle:As the Result . . . . .	273
11.6.2	Origin of Study Contents of This Book . . . . .	274
	Writing notes: sequence of volumes and putting everything in greater perspective . . . . .	275
	References . . . . .	276
	<b>My Views on Learning English</b> . . . . .	279
	References . . . . .	280
	<b>Name Index</b> . . . . .	283
	<b>Subject Index</b> . . . . .	285

## About the Author

**Hirotda 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  $\equiv$  the increase of total utilities are gotten hold of usually as direct effects plus indirect effects, technological external economies and



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).

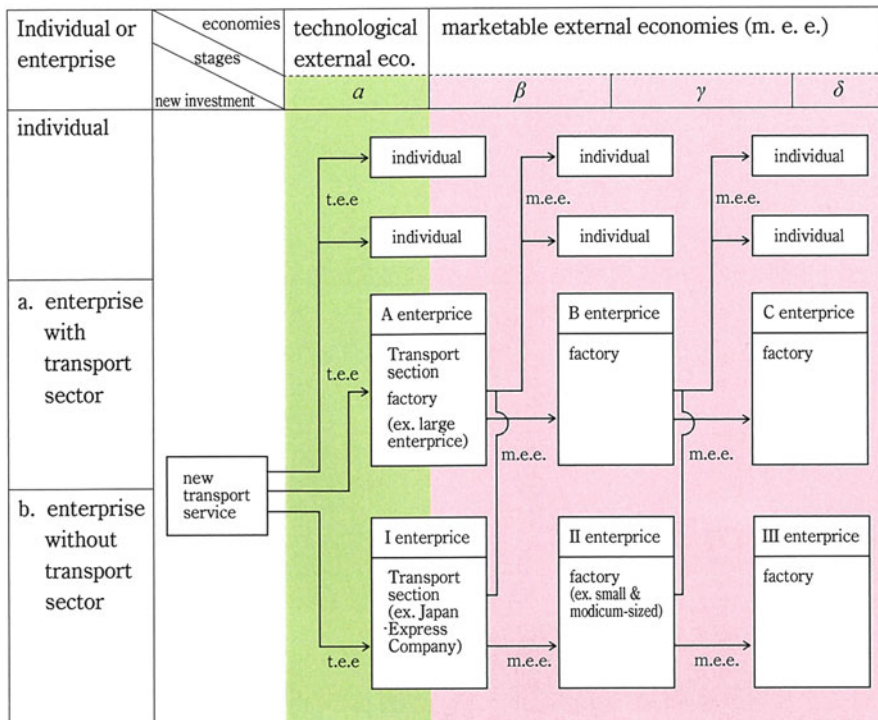
In this paper, under the pressure of necessity that we must grasp radically and accurately the *essence* and total amount of economic effects of *public* investment, the argument based on Scitovsky's definition will be evolved, not driving it out, but in the course of receiving it partially.

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



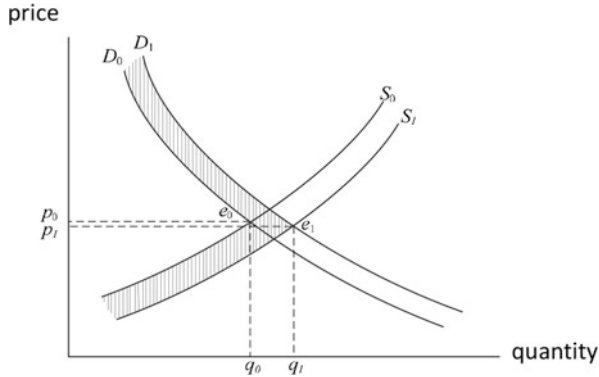
**Fig. 1.1** Propagation/diffusion process of economic effects brought about by new transport facilities—technological and monetary external economies. (Source: Kohno [1], p. 208)

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,  $i = 1, \dots, m$ ; and  $t = 1, \dots, n$ ) and social discount rate be  $\pi$ , then economic effects here are grasped to be:

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

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:

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

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 necessities, 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 necessities, 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:

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

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.