INTRODUCTION

Cities are concentrations of people, and the essence of urban life is the presence, for better and for worse, of many other people. It could be argued that the essence of urban economics is therefore the analysis of externalities. Traffic congestion, discrimination, pollution, and public services all involve externalities, and all are important matters of public policy. To design better policies, the implications of externalities within a decentralized market system must be understood

The kind of interactions most often analyzed in economics are transactions of ordinary private goods which are bought and sold by individuals at a market price. This type of interaction always involves flows in two directions: a payment is made whenever a good is transferred. This book is concerned with interactions of a different kind - with externalities and public goods, in particular.

Externalities arise when an agent does not compensate others for the effect of his actions. Smokers who do not, for example, pay for cleaning windows, or for the damage they may do to others' health, or for the discomfort they may cause, produce a variety of externalities. Urban life, in fact, is filled with examples of externalities, some of which we consider in this book: firms often prefer to locate in larger cities because of the presence of other firms; individuals sometimes choose to avoid certain neighbourhoods because of the presence of certain ethnic groups; commuters find their travel costs increased because others choose to travel at the same time.

Public goods are goods that are consumed jointly by many individuals. A private good has the property that consumption is exclusive: if an individual eats an apple, nobody else can eat the apple. In the case of a public good, such as national defense, consumption of the good by one individual does not prevent others from consuming the good at the same time. As it turns out, it is difficult to achieve an efficient supply of a public good through the market, and most public goods are provided by the government.

There are different degrees of publicness in different public goods. At one extreme is the pure public good which is consumed by all individuals in the economy simultaneously and which it is impossible to prevent anyone consuming once it is supplied. The classic example is national defense. Most public goods are not pure in this sense, however. In this book we consider public goods which are jointly consumed but only by those who live closer to the place of supply. Parks, street lighting, or sidewalks are typical of such local public goods.

With the exception of Chapter VI, the book is concerned with the *normative* aspect of externalities and public goods, or with what *should* be done if there are externalities or public goods. There are two major issues in normative analysis: *efficiency* and *equity*. The aspect of efficiency is usually represented by the concept of Pareto optimality. *An allocation is called Pareto optimal if nobody can be made better off without making somebody else worse off.* Pareto optimality ignores distributional equity, however: the allocation with only one individual obtaining all the wealth and the

rest of the population starving to death may well be Pareto optimal. Although the problem of equity is extremely important, Chapter VI is the only chapter that deals with the problem of income distribution, and our analysis there is *descriptive* rather than normative.

For the sake of simplicity, we usually restrict our analysis to the case in which all households obtain the same utility level, and then examine the optimum at which the common utility level is maximized. Using this procedure, the income distribution is necessarily the one that yields equal utilities. Since we are interested in the properties of an efficient allocation in general, and not the properties of this particular income distribution, it is fortunate that many of the results in the equal-utility case either apply directly to more general cases, or approximate the results in the general case at a Pareto optimum.

The book therefore deals primarily with the efficiency aspect of externalities and public goods. The best starting point for the analysis of efficiency is the *Fundamental Theorem of Welfare Economics.* The Theorem examines the optimality of competitive equilibrium, where competitive equilibrium is, roughly speaking, the allocation at which supply equals demand for all goods, with all agents taking prices as given. Assuming that all goods are private goods and that no externalities exist, it has been shown that a competitive equilibrium is Pareto optimal under some mild regularity conditions, and that under the additional assumption of convex preferences and a convex production possibility set a Pareto optimal allocation can be achieved as a competitive equilibrium. Thus in the sense of Pareto, competitive equilibrium is optimal. This result, however, breaks down if there are externalities or public goods.

In making decisions, individuals who generate externalities do not take into account the external effect on others. Their decisions therefore must be corrected to include the external effects. Introducing a Pigouvian tax/subsidy is one way of modifying individual decisions in order to achieve an efficient allocation. When, for example, there is traffic congestion producing an externality among travelers, a Pigouvian tax on congestion can be imposed. An efficient allocation results if the tax each traveler pays is equal to the marginal cost she imposes on others by traveling. The problem with the Pigouvian tax/subsidy is that it usually requires very high administrative costs. Chapter II considers the case of a special kind of Marshallian externality, and explores the possibility of internalizing the externality through the ownership of land.

Schemes for making agents pay all the costs they impose on others are sometimes too costly. Policy makers may then want to achieve the best allocation possible when relative prices are distorted by an unpriced externality. This is the *second best problem.* The second best problem turns out to be much more complicated than the first best. In Chapter V, we examine an example of a second best problem - deciding how much road to build when congestion tolls cannot be levied.

A public good is supplied efficiently if the marginal cost is equal to the sum of the marginal benefits received by all individuals who consume the good. It is, however, extremely difficult for the supplier of the public good to know how much people benefit. In Chapter III, we examine whether it is possible to devise a competitive system that achieves an efficient allocation of *local* public goods.

We analyze externalities and local public goods within extensions of a standard

residential-land-use model. The basic features of our cities are as follows. A city is built on a flat featureless plain. All residents in the city work in the central business district (CBD) at the center. People in our model travel only between their homes and the CBD. Travel is equally costly in all directions, so that the only spatial characteristic of any location that matters is the distance from the city center. We can therefore treat the city as if it were one-dimensional.

The city may be closed, in which case the population of the city is fixed; or open, in which case migration into and out of the city is allowed. We often consider the extreme case of an open city which is small compared with the rest of the world, so that the utility level of the residents is fixed from outside. We also consider an economy consisting of many cities.

We consistently assume that commuting costs are the only transportation costs incurred in the economy. This assumption is a reasonable first approximation, since transporting human beings is much more costly than transporting most commodities. The way transportation costs are introduced marks the boundary between conventional location theory and the approach based on residential land use which was called the new urban economics by Mills and MacKinnon (1973). In location theory, there are no commuting costs, nor even workers, but transporting goods is costly.

One of the advantages of our approach is that we can assume without being logically inconsistent that producers are perfectly competitive, since if there are no transportation costs for products, they compete each other directly in the world market. In location theory a producer has monopoly power in the market area surrounding his factory because more distant producers have higher transportation costs. Competition occurs only at the boundary between different producers, and if a producer raises the price of the product, his market area becomes smaller but, in contrast to what happens in the case of perfect competition, demand for his product does not fall to zero. Since we avoid the complications arising from the monopolistic element, we can introduce other complications, such as externalities, without making the analysis intractable.

It is not our purpose to elaborate a comprehensive theory of urban externalities. Rather, we isolate each particular kind of externality in a very simple model, and focus on its special properties. We often concentrate on polar cases to obtain clear-cut results. In those cases the results should not be taken too literally: they simply illustrate the directions of basic forces which operate in more general cases.

This strategy reflects our belief that the only way to understand a very complex real world is to construct simple imaginary world, each of which includes one, or a few, important aspects of the real world, and to study their workings. Once we understand the simple models, they can be made more complicated by combining them or by introducing more realistic elements, and eventually we may understand all the important aspects of the real world. This view was eloquently expressed by R.M. Solow (1973) :

> Simplifying assumptions are not an excrescence on model-building; they are its essence. Lewis Carroll once remarked that a map on the scale of one-to-one would serve no purpose. And the philosopher of science Russell Hanson noted that if you progressed from a five-inch balsa wood model of a Spitfire airplane to a 15-inch model without moving parts, to a half-scale model, to a full-size entirely accurate one, you would end up not with a model of a Spitfire but with a Spitfire. He then remarked that if you equipped the Spitfire with illuminated tubing in red, blue and green to illustrate the fuel, ignition and hydraulic systems, it would again be a kind of model but mainly by virtue of its differences from the real thing.

Our analysis is confined to the economic aspect of cities. Sociological and political aspects enter our analysis only as an environment which is taken as given. Narrowing our scope allows us to use some of the more powerful tools from the economist's tool kit. We hope that the precision we gain justifies the generality we lose.

As in standard economic theory, we assume that rational individuals act according to consistent preferences which can be represented by a well-behaved utility function. Although we do not believe that all people behave rationally all the time, it is clearly a better assumption than that people are always fools, for example, or that every decision is made by flipping a coin. The limits of the assumption, however, must be borne in mind.

The organization of this book is as follows. In Chapter I, we formulate a simple residential land use model which serves as the basis for later developments. The model captures the trade-off between commuting costs and lot size in the simplest possible form. In order to compensate for a rise in commuting costs, the lot size must increase with distance from the center, which is made possible by a fall in land rent. We introduce the concepts of a closed city and a small open city, and analyze both competitive equilibria and optimal allocations.

We develop a model of an economy consisting of many cities in Chapter II, and analyze the optimum and market city sizes. Two cases are considered: one is the case of scale economy internal to a firm and the other is the Marshallian externality case with scale economy external to a firm but internal to a city.

Local public goods are introduced in Chapter III. We examine how the optimal supply of local public goods is achieved in a decentralized market system.

Traffic congestion and land use for transportation are introduced in Chapter IV. The optimal allocation requires that congestion tolls be levied and that roads are built to equate the marginal saving in transportation costs from widening the road with the land rent. Because of huge administrative costs, however, it is usually impossible to levy the optimal congestion tolls. In the absence of congestion tolls, the investment criterion of roads must also be modified. In Chapter IV we compare the optimal allocation with the market equilibrium where congestion tolls are not levied and roads are built according to the usual benefit-cost criterion. Since the usual benefit-cost criterion of comparing the saving in transportation costs with land rent is misleading when congestion tolls are not levied, we, in Chapter V, explore the second best allocation in which roads are built optimally under the constraint that congestion tolls are impossible.

In Chapter VI externalities between different types of individuals are introduced. Assuming that one type, called discriminators, suffers external diseconomy from the presence of the other type, called nondiscriminators, in their neighbourhood. We examine what kind of spatial pattern emerges given the externality. Using the model we analyze the possibility of a so-called cumulative decay process of a city.

Capital accumulation is introduced in Chapter VII and optimal growth of a system of identical cities is analyzed. The major question asked in the chapter is whether the city size increases in the process of capital accumulation.

There are four appendices after the main text. Appendix I analyzes a problem that arises in Chapter I. In Chapter I, it is found that households receive different utility levels at the Benthamite optimum. We will explore the reason why utility levels are different even though the Benthamite social welfare function is egalitarian. Appendix II extends the analysis of local public goods in Chapter III to a more general model. Appendices III and IV develop two useful mathematical tools. In Appendix III, the *Envelope Theorem* is explained and properties of the *indirect utility function* and the *expenditure function* are derived as applications of the Theorem. Appendix IV gives a brief review of *optimal control theory*, which is used extensively in this book.

It is probably useful to note here that equations from preceding chapters are referred to by adding the chapter number: for example, Equation (2.1) in Chapter I is called Equation (I.2.1) in other chapters.

REFERENCES

Mills, E.S. and J. MacKinnon, (1973), "Notes on the New Urban Economics," *The Bell Journal of Economics and Management Science* 4, 593-601.

Solow, R.S., (1973), "Rejoinder to 'A Comment on Some Uses of Mathematical Models in Urban Economics'," *Urban Studies* 10, 267.