EXTERNALITIES, EFFICIENCY AND EQUITY

Snorre Kverndokk
Ragnar Frisch Centre for Economic Research, Oslo, Norway

Adam Rose
Department of Geography, Pennsylvania State University, USA

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Summary

This paper provides a review of issues related to efficiency, externalities and equity, with a particular emphasis on environmental problems. First, we explain the concept of Pareto Optimality, which is an accepted efficiency principle in economic theory. However, imperfections in the economy such as externalities and public goods will reduce the efficiency of a market economy, and governmental involvement may be necessary to strengthen, supplement or supplant the market.

Second, while economists agree on Pareto Optimality as an efficiency principle, there is not a consensus on a "best" equity principle. Therefore, we survey different theories of equity. Third, we explain the question of the effects on welfare of material growth, and finally, we offer some perspectives on future material growth and the effects on distribution.

1. Introduction

In the first treatise on the workings of a capitalist economy, Adam Smith put forth the doctrine that each individual's pursuit of his/her own self-interest would lead to an outcome in the best interest of society as a whole. This doctrine was important in establishing the worthiness of a system of private property and decentralized decision-making with a minimum of government interference, in sharp contrast to the prevailing Mercantilist philosophy of state control.

The mechanism by which the common good would be achieved, the "invisible hand" by which individuals would be led, was the market. Prices determined by the market reflect the value of resources and guide individuals in using resources wisely. Smith also insisted that the common good should be evaluated as an aggregation of individuals, rather than the separate entity of the State, and therefore what is good for the whole is simply the sum of what is good for the individual parts.

For more than two hundred years, economists have sought to prove Adam Smith's doctrine at various levels of theoretical sophistication. All of these proofs have involved the characterization of a market economy under ideal conditions (e.g., perfect factor mobility, no interdependence between entities outside the market). Also, the definition of "common good," or the societal objective, has typically been a narrow one based solely on efficient resource allocation, thereby omitting such considerations as equity. Smith's doctrine in its various forms has been used to emphasize the natural ability of markets and to imply that government involvement in the economy cannot help, but rather can only make things worse. The real world success of market economies over most of the past few centuries, however, has been even more important to the support of this system. Of course, no actual economy has relied entirely on markets, and all have been characterized by some form of government involvement.

The focus of this chapter is on two major limitations of a market economy. One pertains to "market failure" due to externalities, the most common example of which is pollution. When externalities exist, the full social costs of actions are not taken into account, and market prices fail to reflect the true value of resources. The market fails to allocate resources in an efficient manner because prices give misleading signals. Interestingly, two alternative solutions exist: strengthening the market or government interceding in the market.

The second limitation is that the market is blind to equity, unless we accept the extreme views that equity is not a worthy objective or that the market outcome is an inherently fair one. Below, we discuss equity in various forms and with reference to resources, the environment, quality of life, and economic growth. We will also address the issue of how equity can be pursued in a market economy, including concerns that its pursuit might undercut efficiency.

2. Efficiency

Formal proofs of Adam Smith's doctrine have come to be known as the First Fundamental Theorem of Welfare Economics and are typically stated as "a competitive

equilibrium implies Pareto Optimality," or CE⇒PO. CE refers to the idealized market economy and PO to the condition that an efficient allocation of resources in production and exchange separately and together exists when no one can be made better off without someone being made worse off. (Proponents of centrally planned, socialist/communist economies have derived proofs of the ability of their systems to achieve an optimal allocation of resources in conformance with Pareto criteria as well, for cases where an efficiency objective was considered paramount. One major advantage of a market economy is, however, that the price system provides much of the needed guidance in a relatively inexpensive manner.)

Below, we summarize major aspects of economic efficiency and its policy implications.

2.1 Pareto Efficiency

Efficiency in production is based on the wise use of resources both within and across firms. This requires that various tradeoffs between the relative productivity of inputs be carefully weighed, and that the production be considered in terms of opportunity costs—the amount of one good that has to be given up to produce a unit of another. Efficiency in production is a position at which more of any one good can be produced only by producing less of another. Price signals lead decision-makers to efficient outcomes. The most important criterion on the production side is marginal-cost pricing, which simultaneously guarantees a maximization of individual profits and efficient use of resources from the standpoint of society as a whole.

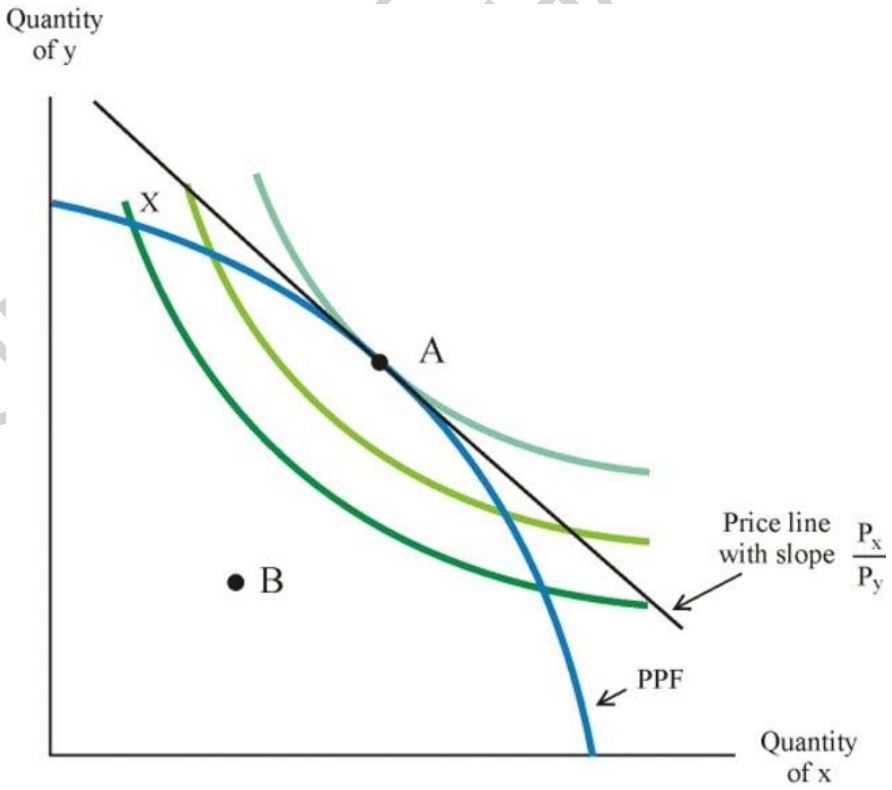

Figure 1. The overall efficiency of a competitive equilibrium.

Production efficiency can be characterized in Figure 1 by the production possibility frontier (PPF) representing all efficient combinations of two outputs, *x* and *y*, that can be produced with a fixed initial endowment of inputs. Points in the interior of the production set, such as B, are inefficient, because they are points at which the output of both goods can be simultaneously increased. The slope of the PPF is the marginal rate of transformation, MRT_{xy}, which indicates how many units we have to reduce the production of good *x* to produce an additional unit of good *y*.

The price ratio of two goods, P_x/P_y, can be represented by the straight line of negative slope in Figure 1. Efficiency in production takes place at the tangency of the price line and the PPF, a position at which the technological rate of tradeoff is equal to the market rate of tradeoff.

Efficiency in consumption or exchange involves similar tradeoffs between goods consumed. We can conceive of a preference ordering by consumers that reflects the satisfaction, or utility, they receive from goods or services. It is typically assumed that consumers prefer more to less, and that they prefer some combination of two goods to extreme combinations of one or the other. These considerations are embedded in a set of community "indifference curves" in Figure 1. Each such curve represents quantities of the two goods yielding the same level of satisfaction, so that the consumer is indifferent between them, but as we move in a northeasterly direction the curves represent higher levels of utility. The relative preference for balanced combinations of the two goods gives the indifference curves their "bowed," or convex shape.

Intuitively or explicitly, the consumer compares the subjective rate of tradeoff with the market rate of tradeoff and equalizes the two. The subjective rate of tradeoff is referred to as the marginal rate of substitution, MRS_{xy}, and is the slope of the indifference curve. It indicates how many units of good *x* the consumer is willing to give up to get an additional unit of good *y*.

The same price ratio that guides producers also guides consumers, so that the highest attainable indifference curve (the maximization of utility for society as a whole) is tangent to the PPF, as well as tangent to the price ratio, see point A in Figure 1. This point of overall (producer and consumer) efficiency is typically referred to as Pareto Optimality—a point at which one person in society can be made better off only by making someone else worse off (through reallocations in production or exchange). That is, not only are goods produced in the most efficient way but also in quantities that meet consumers' needs and wants (preferences).

Two important considerations should be emphasized. First, the attainment of Pareto Optimality by a market economy requires many assumptions, some of them are for convenience and do not alter the basic result, but others are serious departures of reality and do significantly affect the outcome. Examples of the latter include the assumption of rational behavior (that individuals do in fact maximize), that no individual firm has influence over prices, or that there are no interdependencies outside the market (see the further discussion below). Major controversies exist over the implications of these assumptions; to some they undercut the viability of a capitalist system, while to others

they are minor aberrations. We do not attempt to resolve the controversy here but simply to note the important principles relating to the value of resources and their wise use, which are the main focus of individual decision-makers and the goals that nearly all economists believe are important for society as a whole. Also important is the fact that the foregoing evaluative framework focuses on economic efficiency and ignores other objectives. Moreover, in the Pareto framework, only human welfare counts, as do only those goods provided by the market. For many years, decision-makers, and even some economists, explicitly or implicitly concluded that if something did not have a price it did not have value. The environment is a good example of the error of this perspective, and many of the principles just discussed and those in extensions below are being increasingly applied to improving the allocation of environmental resources.

2.2 Imperfections

There are four major sources of market failure that are typically considered to require market intervention, all having significant relations to natural resources and the environment. (The market can also fail to allocate resources efficiently if several of its other ideal assumptions are violated, e.g. due to the presence of imperfect information or limited factor mobility. However, solutions to these deficiencies typically involve market-strengthening measures.)

The first source of market failure is imperfect competition, brought about by the existence of only one (monopoly) or a few (oligopoly) firms. They under-utilize resources as a result of limiting output in order to raise the price, and hence profits. The solution to this source is usually government intervention in the form of anti-trust legislation.

The second source is natural monopoly, or decreasing cost industries. Here economies of scale have no limit, and hence the "natural" outcome of competition would be the survival of that single firm that grew faster than all others. Ironically, this enterprise could potentially supply its product to consumers at the lowest possible price, but would be tempted to exercise its monopoly power. Governments typically step in to legitimize the monopoly but to regulate pricing. Electric utilities and natural gas pipelines are two major examples of natural monopolies, though it has recently been realized that only the transmission of electricity, rather than its generation is the natural monopoly element. Unbundling these two aspects is the basis for the recent push toward deregulation of electric utilities and the emergence of markets for the power generation component. The remaining two market failures will be discussed more extensively below.

2.2.1 Externalities

Externalities refer to one person's/firm's behavior affecting other person's/firm's well-being/profit without the action being transmitted through the market. Externalities can be both positive and negative, the most prevalent version being the latter in the form of environmental pollution. That is, the dumping of one person's pollution into the environment imposes harm on one or more others without any compensation. Some positive externalities also pertain to the environment, such as the development of parks or the preservation of open space, which raise values of neighboring private property.

Externalities were once thought to be aberrations of the workings of the market system. However, the Materials Balance Theory demonstrated that externalities are an inherent and pervasive outcome of economic activity. According to the second law of thermodynamics, energy and material transformations can never be 100% efficient. The inefficiencies manifest themselves in wastes or residuals, which, according to the law of the conservation of matter and energy, do not just disappear. Unfortunately, the environment is often considered to be a free dumping ground for these wastes (pollution is defined as the buildup of these wastes beyond the assimilative capacity of the environment). In short, the materials balance principle states that all inputs into production eventually come out as waste (either as byproducts of production or as the end product of consumption—we do not actually consume goods but simply the services of them, the waste products being in the form of packaging, automobile hulks, sewage, etc.). Therefore the volume of residuals is equivalent to the volume of the vast tonnage of material inputs into the economy.

In essence, decision-makers consider the private costs of their actions but not the external costs they impose on society. Socially optimal pricing requires that price equals marginal costs, but in the presence of externalities one must distinguish between social costs and private costs. Individual decision-makers set their prices equal to only the private marginal cost component. Various perspectives on how to deal with externality problems, to be discussed further below, involve ways for decision-makers to consider or internalize social costs. In an overall framework, one would reduce pollution or other externalities to the point at which the marginal social cost equals the marginal social benefit. This point of intersection is unlikely to be at either a zero or total control of pollution. (Note that the latter is unlikely in any case because of the limitations of technology and the fact that what we often refer to as pollution control simply transforms a waste product from one form to another). Thus, solutions according to mainstream economics do not call for the complete elimination of pollution, but only pursuing or tolerating an optimal amount. All pollution is referred to as an externality, but only the amount up to the point of optimality is considered "Pareto-relevant."

This result is unsatisfactory to many who view this framework as being an apologist approach to pollution problems. However, there are features of market economies that provide us with some faith that the optimal level of pollution will be reduced in the future. First, as income increases, people place a greater benefit on the environment (see also below). Also, over time there are incentives for reducing the costs of pollution control. In fact, one of the main themes of industrial ecology is the harmonious pursuit of economic growth and environmental quality, which can be attained in some instances with bold reformulations of entire production processes. Many economists, and, probably more importantly many business decision-makers, are finding that sound environmental practice is good for the bottom line. Moreover, a large environmental protection industry is gaining strength that will serve as a powerful interest group in giving visibility to environmental problems.

2.2.2 Public Goods

The second major type of market failure is becoming increasingly important because both the environment and pollution control fall under this heading. A public good is

distinguished by two characteristics: 1) two or more people can consume it simultaneously, and 2) it is technologically infeasible, economically impractical, or socially unacceptable to exclude people from it. If the first characteristic, "non-rival consumption," goes to the extreme, i.e., where no one's consumption detracts from anyone else's, the good is considered a pure public good (e.g., a magnificent sunset, pollution control, and national defense). Otherwise, it is deemed congestible or exhibiting some degree of "publicness" (e.g., a park, or the environment in general). Two intermediate cases should be noted. A good that exhibits characteristic (1) but not (2) (e.g., a movie theatre) is usually provided optimally by private markets. A good that exhibits characteristic (2), but not (1), is known as a common property (or open access) resource. For example, in an ocean fishery or oil field, every unit extracted is rival, but it is difficult to restrict access. In this case, a market failure often arises because of degenerate competition from over-exploitation.

Market failures arise for public goods for two main reasons. First, the value of a public good to society is the sum of individual values (minus any congestion). Thus, the value to society is more than any individual would pay, and its optimal provision requires an unusual pricing mechanism (e.g., individualized user fees). Second, if a person cannot be excluded, he/she has every incentive to let a neighbor fund the good and simply become a "free rider."

Analysts originally suggested that most public goods could only be optimally provided by government. Today, a host of remedies are available as discussed below.

2.2.3 Government vs. Market Responses

For many years, environmental problems persisted without remedy. The first wave of responses involved government regulation that placed limits on pollution discharges. These regulations were often linked to standards that only approximated to the marginal benefit function and were thus doomed to inefficiency at the outset. They were also not "cost-effective" (a lesser requirement that simply means an objective is attained at lowest overall cost), because they were applied equally to all polluters and did not consider their variations in control costs.

More recently, economists have emphasized the value of incentive-based systems, which provide greater flexibility and choice in compliance than government "command and control," and are thus more likely to lead to an efficient allocation of resources. This approach can best be explained if we examine the question of why people pollute. As noted earlier in the Materials Balance Theory, waste products are an inevitable part of economic activity. People then have two choices: 1) use the environment as a free dumping ground, or 2) pay for cleanup. Most producers and consumers act in their self-interest and take the former course. The alternative approach is to find ways to make pollution control a goal of self-interest itself.

The reason that the environment is used as a free waste receptacle is that it is commonly owned. No private ownership or common ownership means no custodial responsibility. This is clear if we think about where we find most litter—it is not in people's front yards but along public highways and public waterways.

One incentive-based system is to tax pollution directly or to tax the output or inputs that produce it (subsidies for pollution control work the same way but are less favored politically because they seem to reward polluters). The polluter then has the freedom of choice in responding, and self-interest will lead to the socially desirable level of pollution if the tax reflects the external costs. Moreover, the flexibility of choice utilizes the variation in control costs to achieve the least-cost combination of mitigation measures.

The most novel approach to the problem, however, emanates from the Coase Theorem, which states that (Pareto relevant) externalities can be eliminated if property rights can be clearly delineated and traded in the market, irrespective of who receives the rights (and assuming that transaction costs and income effects are minimal). For example, in the case of tradable permits for carbon dioxide emissions, those countries or entities whose control costs were above the market permit price would purchase permits from those whose control costs were lower than the permit price. In essence, by assigning property rights, people are given a stake in the environment and find it in their self-interest to use it wisely. A person can pollute or sell his/her property right(s) at a profit, and hence there is an opportunity cost to pollution.

Early opposition to the property rights approach was strong, since it appeared to reward polluters (if they were the ones given the rights), or in general seemed to "give the fox the key to the hen house." However, this overlooks the establishment of incentives (essentially the "internalization" of the externality), and the fact that cap on pollution is guaranteed at the outset by assigning a number of permits lower than the level of baseline emissions.

Several concerns about the Coase Theorem have been voiced, and there are many instances where transaction costs and income effects are high and pose problems. Also of concern are distributional or equity considerations about who should actually receive the rights. One important example, to be discussed below, capitalizes on the fact that the property rights solution eliminates the efficiency-equity tradeoff, since there is a uniquely efficient outcome no matter how rights are distributed.

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Biographical Sketches

Snorre Kverndokk was born in 1962 in Trondheim, Norway. He graduated in economics (Cand. Oecon) from the University of Oslo in 1988 and got his Ph.D (Dr. Polit) from the same university in 1994. The title of the thesis was *Essays on Cost-effectiveness, Efficiency and Justice in International CO_2 Agreements*. He has published papers in profiled journals such as *Journal of Environmental Economics and Management*, *Resource and Energy Economics*, *The Energy Journal*, *Energy Economics*, *Energy Policy*, *Environmental Values, and Environmental Economics and Policy Studies*. In 1993 he received the *IAEE Award for "Energy Journal Best Paper"*. Kverndokk is currently a Research Economist at the *Ragnar Frisch Centre for Economic Research*, and has held previous positions at Statistics Norway and Department of Economics, University of Oslo, in addition to sabbatical visits to University College London and University of Colorado at Boulder. He is a Lead author in the third assessment report from the Intergovernmental Panel on Climate Change (IPCC), Working Group III. In addition to environmental and resource economics, his research interests also include welfare economics and health economics.

Adam Rose is Professor in the Department of Geography at The Pennsylvania State University, where he previously served as Professor and Head of the Department of Energy, Environmental, and Mineral Economics. Before joining Penn State, he served as Professor and Chairman of the Department of Mineral Resource Economics at West Virginia University, Assistant Professor in the Department of Economics at the University of California-Riverside, and Senior Council Economist for the New York State Council of Economic Advisers. He holds a B.A. degree in economics from the University of Utah, and M.A. and Ph.D. degrees in Economics from Cornell University.

He is the author or co-author of several books including: *Engineering and Socioeconomic Impacts of Earthquakes* (MCEER, 1998), *A Global System of Tradable Carbon Entitlements* (United Nations, 1992), *Natural Resource Policy and Income Distribution* (John's Hopkins University Press, 1988), *Forecasting Natural Gas Demand in a Changing World* (JAI Press, 1987), *Geothermal Energy and Regional*

Development (Praeger, 1978), and co-editor of *Economics of Natural Hazards* (Edward Elgar, forthcoming), *Frontiers of Environmental Economics* (Edward Elgar, 2001) and *Frontiers of Input-Output Analysis* (Oxford University Press, 1989). His work has also been published in such periodicals as *The Energy Journal*, *Journal of Environmental Economics and Management*, *Land Economics*, *Resource and Energy Economics*, *Annual Review of Energy and the Environment*, *Environment and Development Economics*, *Journal of Regional Science*, *Applied Economics*, *Economic Systems Research*, *Energy Economics*, *Energy Policy*, *Resources Policy*, *Environment and Planning*, *Journal of Energy and Development*, *International Environmental Agreements*, *Environmental Hazards*, *Global and Planetary Change*, and *Climate Research*.

Professor Rose serves on the editorial boards of the *Journal of Regional Science*, *Resource and Energy Economics*, *Pacific and Asian Journal of Energy*, *Energy Policy*, and *Resource Policy*. He has served on expert panels of the National Academy of Sciences, National Science Foundation, U.S. Department of Interior, and Earthquake Engineering Research Institute. He has served as the American Economic Association Representative to the American Association for the Advancement of Science. He is also the recipient of a Woodrow Wilson Fellowship and the American Planning Association's Outstanding Program Planning Honor Award.