GROWTH, TRADE AND THE ENVIRONMENT

Peter Kennedy
Department of Economics
University of Victoria

20 November 1998

This monograph was written for the *Economic Development Institute, World Bank.*

TABLE OF CONTENTS

1. Introduction and Overview

Trade liberalization and multilateralism are the key elements of economic globalization. The increasingly free flow of trade and investment between countries, and the widening scope of international agreements and cooperation, is tying together the national economies of the world ever more tightly into a truly global economy. This has raised concerns in some quarters about the erosion of national sovereignty, the disruptive effects of increased global competition, and the potential for widespread environmental degradation. In other quarters, economic globalization is seen as the route to increased prosperity for all people through the cooperative pursuit of common goals. Both sides have legitimate points to make. While the potential certainly exists for universal prosperity through globalization, the realization of that potential will rely on the careful design of policy to manage change, and to direct competitive forces for the common good. The fostering of sustainable development is an integral part of that policy goal.

1.1 Sustainable Development and Materials Balance

Before examining the specific links between sustainable development, trade and the environment, it will be useful to begin with a brief review of the *materials balance framework* for examining the interaction between the economy and the environment.

The materials balance framework is illustrated in Figure 1.1. The economy draws upon *natural capital* - the elements of the natural system that we usually think of as “natural resources”, such as air, water, fertile land, forests, fisheries, mineral deposits and fossil fuel resources - and reconfigures that natural capital to produce services to satisfy human wants. Materials must balance in the natural system, so any utilization of natural capital

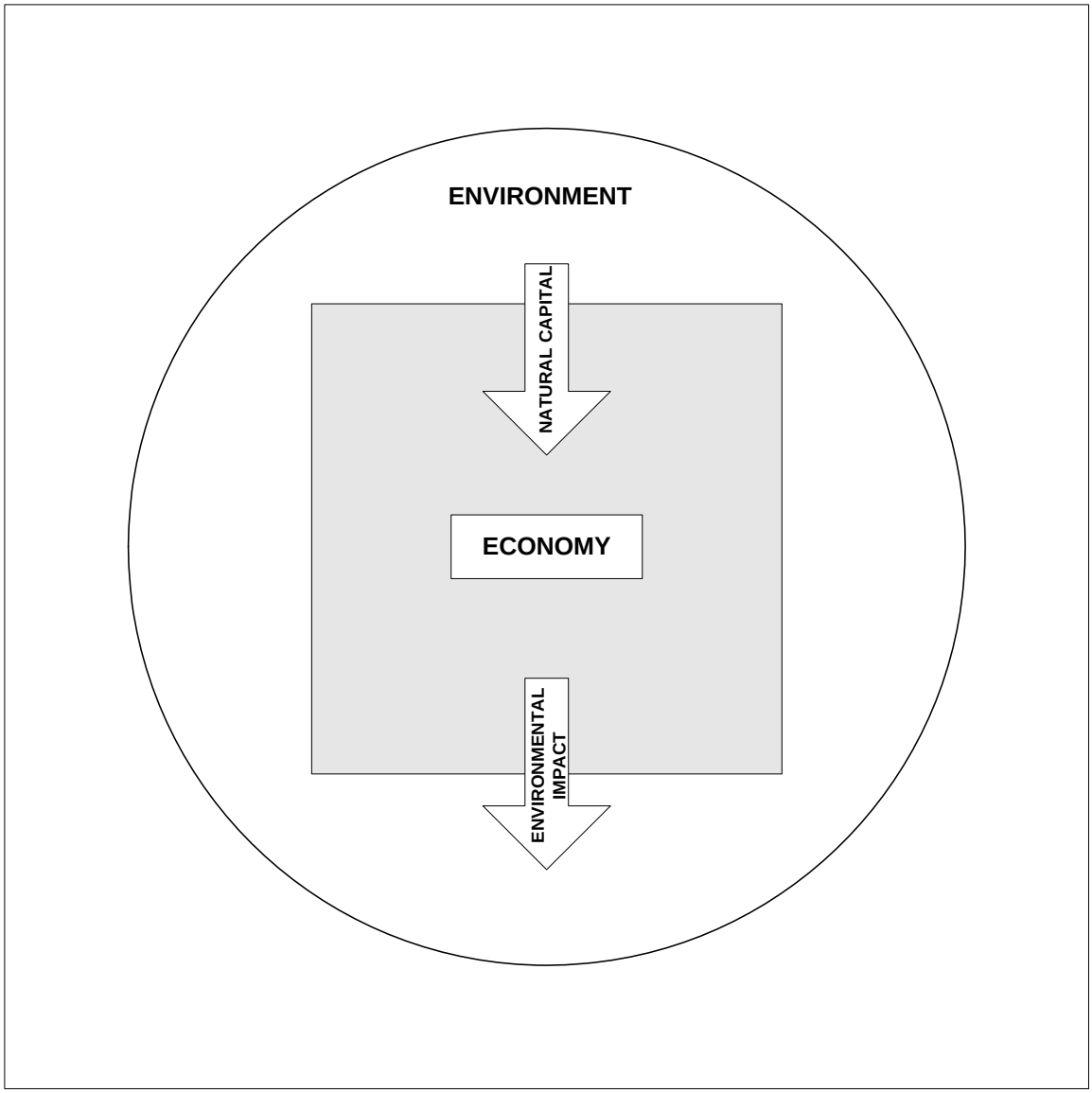

Figure 1.1

Materials Balance: the Economy and the Environment

must be accompanied by an *environmental impact*.[1]

As an example, consider the combustion of natural gas to produce heat for electricity generation. The natural gas is combined with oxygen to produce heat; carbon dioxide and water are produced as by-products. There is a material balance in this chemical reaction: the same number of carbon, hydrogen and oxygen atoms exist before and after the combustion process.[2] The combustion simply rearranges those atoms and produces heat in the process (by releasing energy stored in chemical bonds). This production process can be viewed as a deliberate reconfiguration of natural capital for the purpose of creating a valuable service, namely, heat. The reconfiguration of natural capital constitutes the environmental impact of the heat production process: the production of carbon dioxide and water is a necessary consequence of producing heat from natural gas and oxygen. All aspects of economic activity can be viewed in a similar way.

It must be stressed that there is nothing necessarily inappropriate about this reconfiguration of natural capital to produce economic services. Natural capital is continually being reconfigured in the natural system even in the absence of human activity. For example, the process of photosynthesis by plants uses energy from sunlight to transform carbon dioxide and water into biomass and oxygen; the process is essentially one of reverse combustion. In this way, the natural system acts as a recycling process. This means that, in principle, it is possible for the economy to continually reconfigure natural capital to produce valuable services, and for that reconfiguration to be continually reversed through the natural system.

Environmental degradation occurs when the rate of reconfiguration of natural capital exceeds the *assimilative capacity* of the natural system. That is, if economic activity attempts to force materials through the natural recycling system at too fast a rate, then the system begins to change, possibly in a way that is detrimental to human welfare. For

[1] The materials balance framework is based on the first law of thermodynamics, which states that energy can be neither created not destroyed. A close approximation to this is that matter is neither created nor destroyed in any chemical process; hence the notion that materials must balance.

example, the combustion of fossil fuels around the world (like the natural gas in the combustion example above) has released quantities of carbon dioxide far in excess of what can be assimilated through photosynthesis (especially given the declining global vegetation cover), so this carbon dioxide has accumulated in the atmosphere. The likely result is global climate change via the "greenhouse effect". Thus, there are limits on the rate at which economic activity can utilize natural capital and at the same time sustain that natural capital for future use.

This does not necessarily mean that there are limits to growth in economic services. Economic activity combines natural capital with *knowledge capital* to produce economic services, and continual growth in economic services may be possible via the substitution of knowledge capital for natural capital.[3] That is, increasing knowledge can potentially allow economic activity to continually do more with less. (The explosion of computing power over the past twenty years, combined with the drastic reduction in materials used, is a dramatic example of the scope for substitution between materials and knowledge). Thus, *sustainable development* - sustained growth in the well-being of humans with no net depreciation in the capacity of natural capital to support that well-being - is achievable, at least in principle.

The policy problem is to ensure that the principle of sustainable development is translated into practice. This is a complex problem, made even more complicated by the web of international linkages between national economies and national environments. A clear understanding of those linkages and their implications for the design of policy is crucial to the attainment of sustainable development in an increasingly integrated world economy.

---

[2] The chemical equation is: $CH_4+2O_2 \rightarrow 2H_2O+CO_2$.

[3] Knowledge capital is often referred to as "human capital" since knowledge is embodied in human skills. Human capital does *not* refer to physical labor, which is more correctly viewed as part of natural capital.

1.2 International Environmental Linkages

There are two important sets of international environmental linkages. The first is through *trade and investment*; the second is through *transboundary environmental impacts*. These linkages are illustrated in Figure 1.2. The figure shows a domestic economy nested within its own domestic environment, which is in turn nested within the global environment. Both the domestic economy and the rest-of-the-world (ROW) economy draw upon natural capital, and through its reconfiguration, produce valuable economic services, together with environmental impacts. Some of these environmental impacts will be transboundary in nature, thus giving rise to a direct link between the domestic environment and the global environment. A less direct, but equally important link exists through trade and investment flows between the domestic economy and the ROW economy. We will briefly discuss each of these linkages in turn.

Transboundary Environmental Impacts

Important examples of transboundary environmental impacts include global climate change (via carbon dioxide and other greenhouse gas emissions and deforestation), stratospheric ozone depletion (via emissions of chloroflourocarbons and related substances), oceanic pollution, biodiversity loss, and the effects of airborne pollutants such as particulates, sulfur dioxide and nitrous oxides. The presence of transboundary environmental impacts means that sustainable development cannot be properly monitored in the context of a single country in isolation; sustainable development is necessarily a global issue. Transboundary effects can undermine even the most careful natural capital management in any individual country since there may be significant degradation of its domestic environment due to factors beyond its boundaries, and beyond its control. Conversely, the appearance of sound natural capital management in any particular country may simply reflect the fact that the adverse environmental impacts of its own economic activity fall more heavily on its neighbors than on itself (due to transboundary transportation of airborne pollutants, for example).

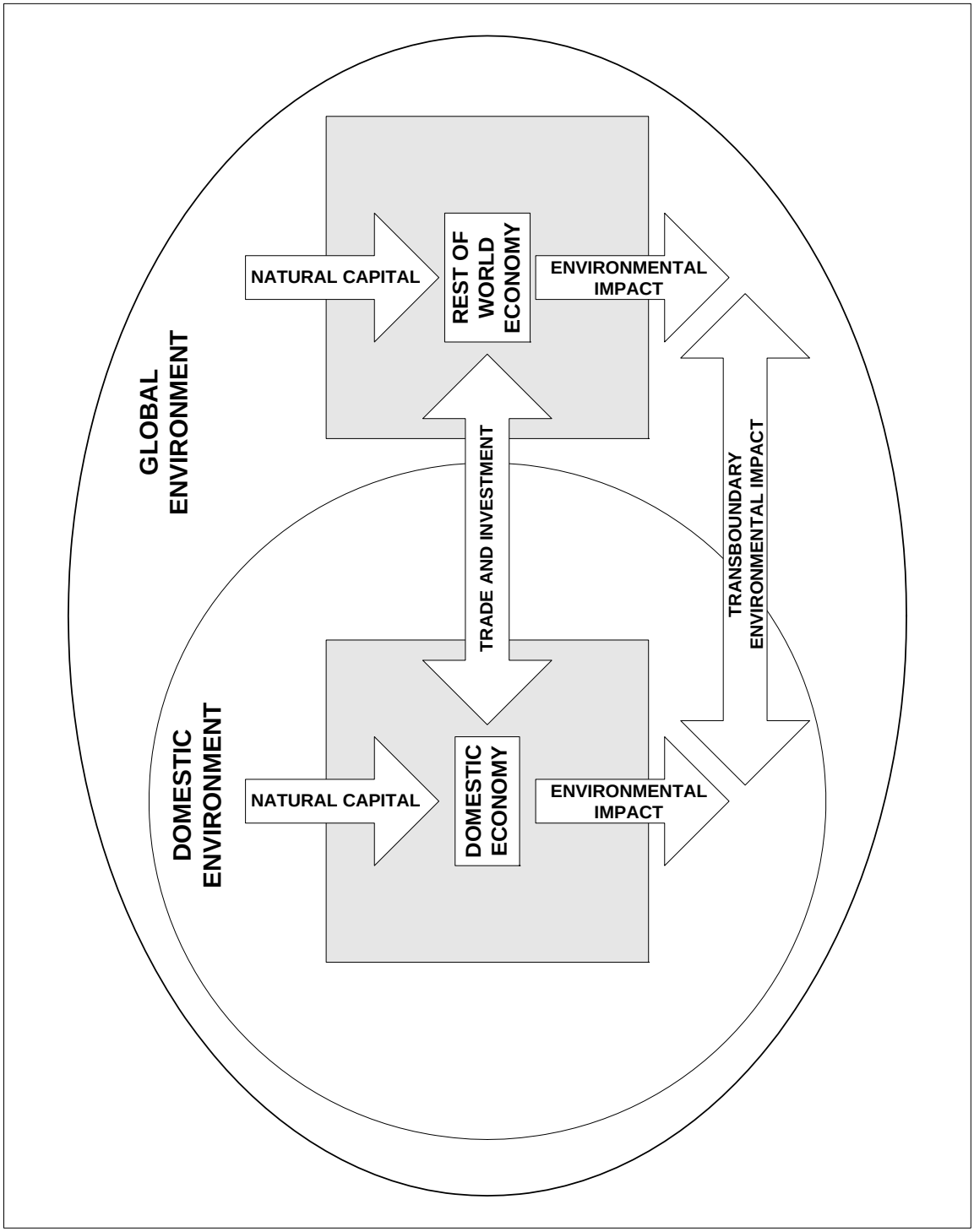

Figure 1.2

The Global Economy and the Global Environment

Transboundary environmental issues are not addressed in detail in this course; attention is restricted to the interplay between transboundary environmental impacts and trade. There are a number of important aspects to this interplay, including the relationship between international environmental agreements and the transfer of technology, and concerns about the impact of compliance with those agreements on competitiveness. These issues are examined in Chapter 7.

International Trade and Investment

The second international environmental linkage illustrated in Figure 1.2 is trade and investment. This linkage is somewhat less direct than transboundary impacts, but it is potentially just as important, and is becoming increasingly so as the volume of trade and investment flows around the world grows. There are two key elements to this linkage.

First, the existence of trade flows between countries causes a *geographical separation* between production and consumption; thus, the environmental impact of production is not necessarily borne by consumers of the product, and similarly, producers of the product are separated from the environmental impact of its consumption. For example, the effects of flooding and soil degradation associated with extensive deforestation are not felt directly by foreign consumers of the harvested timber. Similarly, the problems associated with solid waste disposal faced by consumers of an imported product are not felt directly by the producers of the product in the exporting country. This separation between production and consumption has the potential to blur the link between economic activity and its environmental impact, the clear recognition of which is essential for the attainment of global sustainable development. Moreover, the *jurisdictional separation* that accompanies geographical separation can complicate the problem of designing and implementing policies to foster sustainable development.

In addition, the impact of trade on production and consumption patterns within any country means that trade liberalization, and globalization generally, can cause significant changes in those production and consumption patterns, with associated significant shifts in environmental impacts. If the pace of change is particularly rapid, as it has been in

many developing countries over the past fifteen years, then the policy framework for managing those environmental impacts may fail to evolve quickly enough, with adverse consequences for environmental quality and the attainment of sustainable development.

The second key element of international environmental linkages through trade and investment is the impact that domestic environmental regulation has on competitiveness, and consequently on trade flows, and on the incentives created for governments when setting those environmental regulations. Opponents of freer trade often cite the potential for a "race to the bottom" in setting environmental regulation as a major problem with trade liberalization. The concern is that trading countries will attempt to gain a competitive edge over each other by relaxing environmental standards. If all countries engage in this practice then the outcome may be one in which all countries set lax environmental standards, incurring the associated environmental costs, but with no country actually benefiting from the competition.

While the potential exists for this "race to the bottom" outcome under some circumstances, it is not a necessary consequence of trade, and the problem can in principle be resolved through international coordination. Moreover, the quest for a competitive advantage can also work in the opposite direction. In particular, competitive pressure can in some circumstances lead to an inflation of environmental standards as a disguised protectionist measure, or as a strategy to gain a "technological leader" advantage. The key point to note is that environmental regulations do affect competitiveness, and so there exists the potential for the strategic distortion of environmental policy for trade-related goals.

Thus, international environmental linkages through trade and investment are bi-directional: the production and consumption patterns associated with global trade have substantial environmental impacts, and the policies designed to manage those impacts have important implications for competitiveness and the pattern of trade.
The complex inter-relationship between trade and global environmental quality complicates the policy problem of ensuring global sustainable development, but it must

be stressed that it does not necessarily render the goal of sustainable development less attainable. On the contrary, global trade, and its associated potential to improve living standards in all countries of the world, is a vital component of any prescription for global sustainable development. However, there is a clear role for well-designed, dynamic policies to ensure that the positive potential of trade, and globalization generally, is fully realized.

1.3 Trade and the Environment in Developing Countries

Global trade liberalization has fostered enormous growth in the manufacturing sectors of many developing countries, especially in South East Asia and Latin America, over the past twenty years. That growth is largely attributable to two sources of comparative advantage in these countries: a relative abundance of low-skill labor, and a relative abundance of environmental impact tolerance.

It is important to understand this second source of comparative advantage very carefully. The environments of developing countries do not have a greater *physical* capacity to assimilate waste. For example, the discharge of dioxins into the waterways of Jakarta has much the same physical impact as the discharge of the same dioxins into a waterway in Stockholm. The key difference between the two situations lies in how those impacts are valued. The economic notion of *environmental damage* is based on value; a particular physical environmental impact in Stockholm causes a higher level of environmental damage than the same physical impact in Jakarta because the pristine quality of the waterway is valued more highly in Stockholm than in Jakarta. Equivalently, there is a higher degree of *environmental impact tolerance* in Jakarta than in Stockholm.

Three key factors underlie the differences in environmental impact tolerances across the countries of the world. First, there may be a systematic difference between the

preferences of the individuals who live in various regions.[4] In particular, one group of people may collectively place more weight on the importance of being able to hike in a pristine forest, or on the existence of whales swimming without threat in the oceans, or on a clear view of neighboring mountains. Similarly, one group of people my collectively place more weight on the welfare of future generations than another. Clearly, such differences in preferences exist among the individuals within any particular country, but significant systematic differences across different countries is less pronounced, though arguably observable in some instances.[5] There is no particular reason to believe that such differences account for differences in environmental impact tolerances between developed and developing countries in general.

The second key determinant of environmental impact tolerance is the number of people affected. Environmental impacts are generally "public goods", or perhaps more fittingly, "public bads". For example, exposing two individuals to polluted city air does not mean that each is subject to one half the impact that would fall on just one individual; the exposure of more people simply adds to the aggregate damage. Thus, all other things equal, environmental impact tolerance is generally lower when more people are exposed to that impact.[6]

The third key determinant of environmental impact tolerance is wealth. In particular, the valuation of high environmental quality generally increases with the level of wealth. The difference in wealth levels between developed and developing countries, more than any other factor, underlies the difference in environmental impact tolerances between these two groups of countries. The lower level of wealth in developing countries is the primary source of their comparative advantage in relatively polluting industries.

---

[4] "Preferences" in the economic sense is taken to broadly encompass *all* considerations (including, moral, ethical, and religious) that lead an individual to rank the relative importance of different things.

[5] For example, it is often argued that the peoples of Nordic countries place more importance on a clean environment than some other peoples. Similarly, some national cultures appear to place more importance on saving for the benefit of future generations than other cultures.

This relationship between wealth and comparative advantage in relatively polluting industries often generates a great deal of misunderstanding and fruitless controversy. In particular, the objective recognition of this relationship by policy advisors is sometimes misconstrued as advocacy for making the developing world the environmental dumping ground of the developed world. It is essential that the policy debate on environment and development move beyond this simplistic moral argument. The gap between the wealthiest and poorest nations of the world is enormous, and the argument can be forcefully made that it is appalling. The appropriate way to address that situation is through a cooperative sharing of global wealth. However, the existing wealth differences around the globe, however wrong they may be in the eyes of many, are a fact, and that fact must be recognized in the design of policy, including trade and environmental policy. It generally does not serve the best interests of the people of developing countries to introduce trade and environmental policies that are optimal for countries with ten times their level of wealth. It is essential that developing countries be able to exploit their international comparative advantages in the pursuit of increased prosperity through trade.

This certainly does not mean that there is no need for environmental policy in developing countries. On the contrary, the need for well-designed environmental policies is as pressing in developing countries, and probably more so on many fronts, as it is in the wealthiest countries. The key point to note is that these policies must be tailored to the particular circumstances of those countries, based on a careful assessment of costs and benefits, recognizing that those costs and benefits may not coincide with those in wealthy countries. A battle for the moral high ground must not be allowed to displace sound analysis.

[6] This has particularly important implications for the design of policy in urban areas of developing countries, the rapid growth of which means that increasing numbers of people are being exposed to urban pollutants. (See Chapter 7).

1.4 An Outline of this Monograph

The objective of this monograph is to illuminate the key issues involved in the relationship between growth, trade and the environment, for the purpose of assisting in the design of policies, especially in developing countries.

The monograph is structured as follows. Chapter 2 describes the relationship between production and consumption patterns, and environmental quality. Chapter 3 focuses specifically on the link between energy use and the environment. Chapter 4 discusses the costs and benefits of trade liberalization and multilateralism. Chapter 5 then focuses specifically on the link between trade liberalization, production and consumption patterns, and the environment. Chapter 6 discusses the problems of structural adjustment in response to trade liberalization. Chapter 7 focuses specifically on the problems associated with urbanization in developing countries as a consequence of trade liberalization. Chapter 8 examines the relationship between environmental regulation and international competitiveness. Chapter 9 examines the interplay between trade and transboundary environmental impacts. Chapters 10 and 11 then focus specifically on policy design: Chapter 10 discusses the design of environmental regulation, and the use of economic incentives in particular; Chapter 11 discusses the relationship between economy-wide policies and environmental policy. Each chapter concludes with a synopsis of the main points covered and a list of related readings.

1.5 Synopsis

- Economic activity can be viewed as a process of reconfiguring natural capital for the purpose of producing valuable services, and as such, economic activity must necessarily have an environmental impact.
- The assimilation (or recycling) of materials through the natural system means that economic activity can in principle continually produce valuable services without net depreciation of the natural capital stock.
- The rate at which economic activity can sustainably circulate materials through the natural system is limited by the assimilative capacity of the system.
- Sustainable development - sustained growth in the well-being of humans with no net depreciation in the capacity of natural capital to support that well-being - is in principle achievable through the substitution of knowledge capital for natural capital.
- There are two main sets of international environmental linkages: transboundary environmental impacts; and trade and investment.
- There is a bi-directional link between trade and the environment: the production and consumption patterns associated with global trade have substantial environmental impacts; and the policies designed to manage those impacts have important implications for competitiveness and the pattern of trade.
- Trade is a potentially positive force for sustainable development but the realization of that potential requires the implementation of well-designed policies.
- The design of environmental policy in developing countries must be tailored to the particular circumstances of those countries, based on a sound analysis of costs and benefits, recognizing the importance of trade as a route to increased prosperity.

1.6 Related Reading

Clemencon, Raymond (1997), "Economic Integration and the Environment in Southeast Asia: Securing Gains From Open Markets While Preventing Further Environmental Degradation", *Journal of Environment & Development*, 6, 317-333.

Thompson, Peter and Laura A. Strohm (1996), "Trade and Environmental Quality: A Review of the Evidence", *Journal of Environment &Development*, 5, 363-388.

2. The Environmental Effects of Production and Consumption

2.1 Introduction

Changes in trade and investment flows can have dramatic effects on production and consumption patterns within an economy, which in turn can cause significant changes in environmental impacts. In order to understand the linkages between trade and the environment it is therefore important to first have a good understanding of the relationship between production and consumption patterns, and environmental impacts. The purpose of this chapter is to review some of the key elements of that relationship.

We begin by characterizing the resource flows within an economy, focusing on the links between natural capital, production and consumption. We then examine the most important types of environmental impacts associated with production and consumption activities. We conclude with a brief discussion of general policy principles.[1]

2.2 Resource Flows in the Economy

The basic framework for our discussion is presented in Figures 2.1 and 2.2. Figure 2.1 illustrates the general relationship between the economy and the environment: the economy draws upon *natural capital* to produce valuable services, and through the reconfiguration of that natural capital, creates environmental impacts. Figure 2.2 illustrates in more detail the resource flows within the economy. We will discuss each stage of that resource flow in turn.

[1] See Chapters 10 and 11 for a more complete discussion of policy principles.

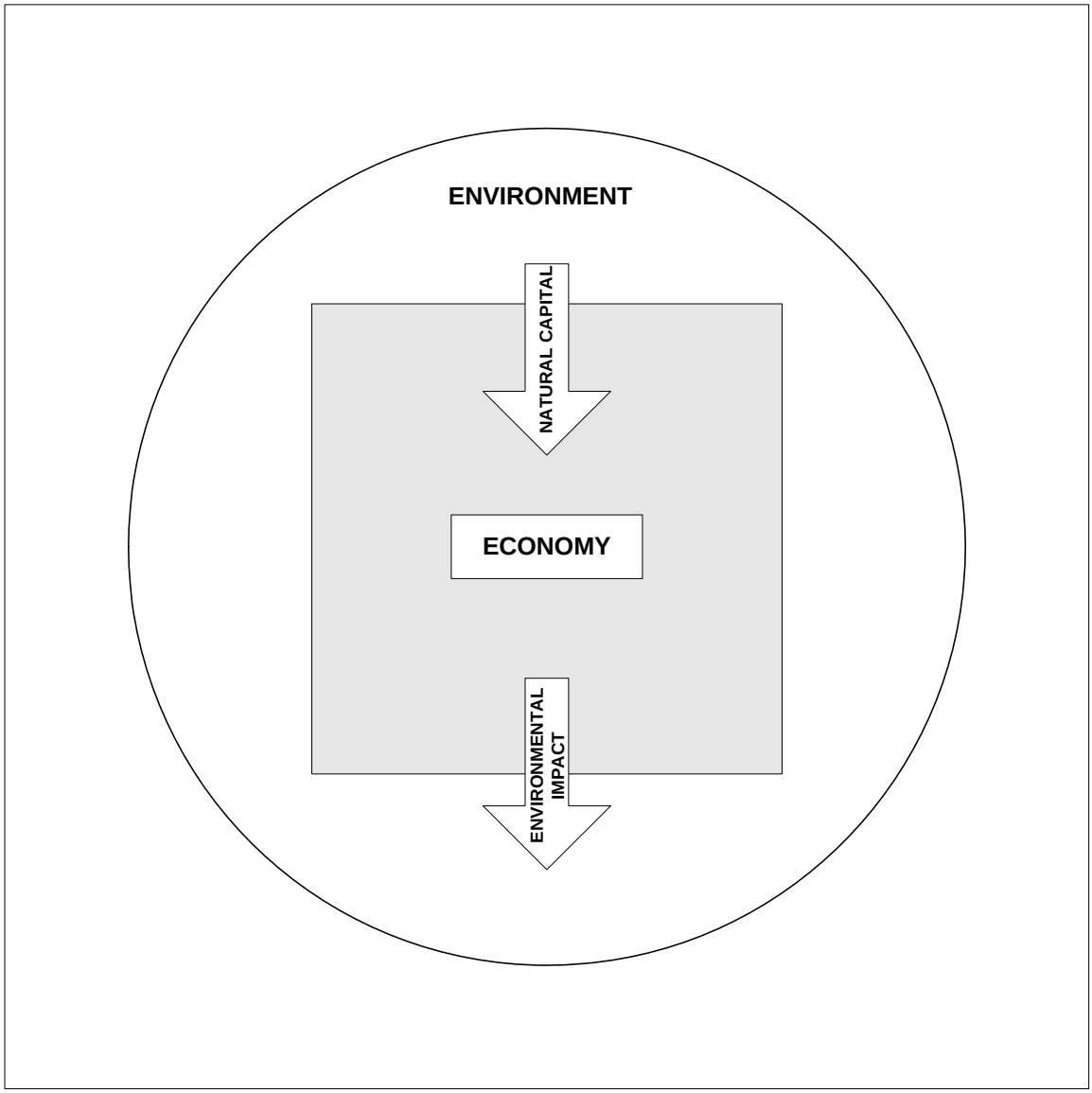

Figure 2.1

The Economy and the Environment

Economic Capital

The first stage in the flow of resources through the economy is the utilization of *natural capital*. The key elements of natural capital for human purposes include basic factors like human labour, breathable air, drinkable water, habitable space, fertile soil, biological diversity, fisheries, forests, mineral and fossil fuel deposits, and navigable waterways.

The utilization of natural capital then allows the production of other forms of economic capital, the most important of which are:

- knowledge capital;
- manufactured capital; and
- social capital.

Together with natural capital, these form the *productive inputs* (or *factors*) of the economy.

Knowledge capital constitutes the stock of human knowledge, and is therefore sometimes referred to as "human capital".[2] Knowledge capital holds the key to the possibility of continued growth in human living standards despite the limits on the capacity of natural capital. In particular, the ever increasing stock of knowledge continually allows humans to produce more economic services with fewer materials, and hence, less environmental impact. This potential for substitution of knowledge capital for natural capital lies at the heart of sustainable development. Of course, there are limits to this substitution: no amount of knowledge will allow the production of something from nothing. Thus, the productivity of knowledge capital relies on some minimal stock of natural capital.

Manufactured capital constitutes the stock of infrastructure, buildings and equipment that are sometimes called "physical capital". Manufactured capital has traditionally been the cornerstone of industrial economies, and while its importance has not grown at the same

[2] Note that human capital does *not* refer to human labor, but to the knowledge that is embodied in skilled labor. Human labor *per se* is an element of natural capital.

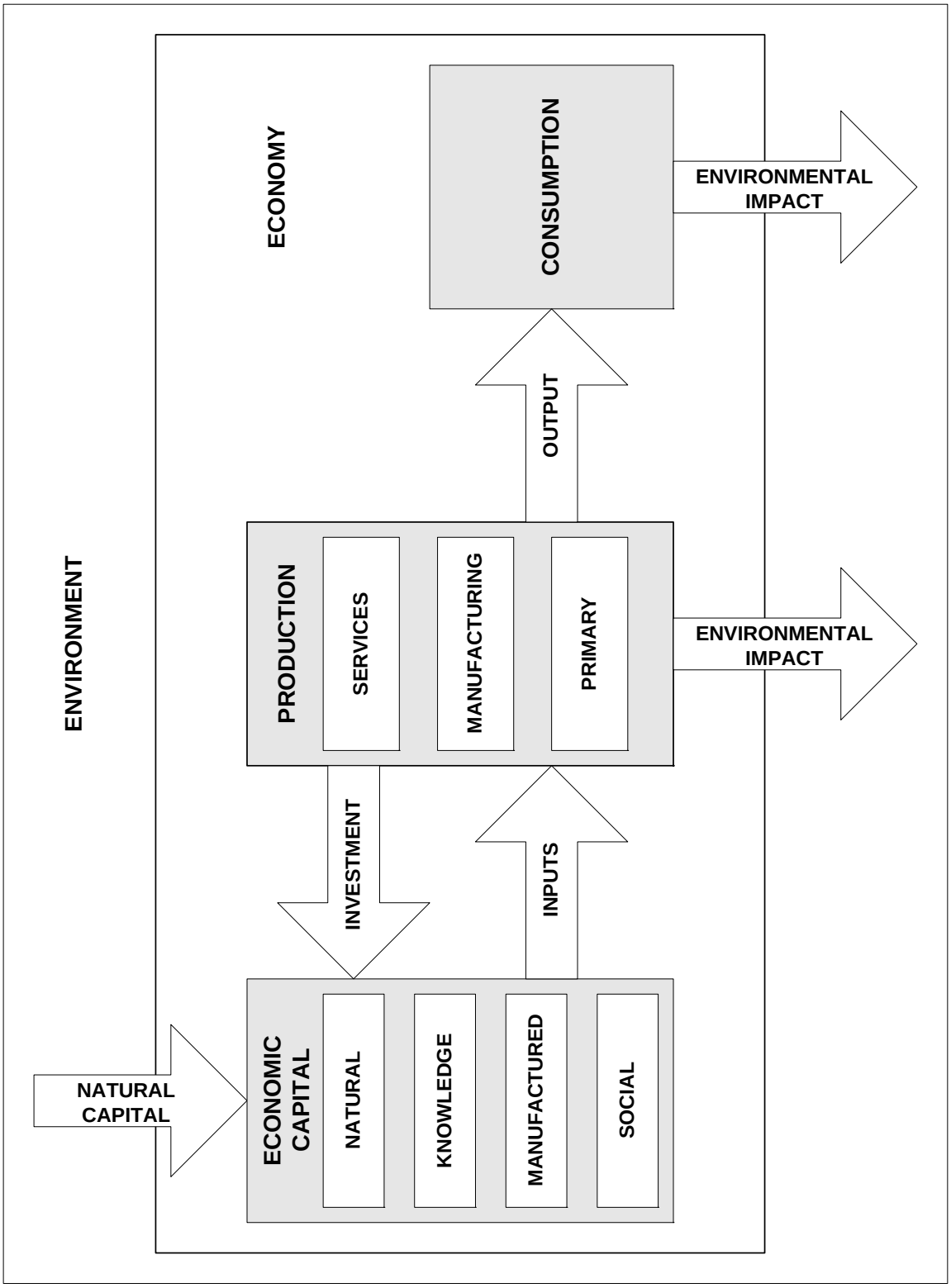

Figure 2.2

Resource Flows in the Economy

rate as knowledge capital in recent times, it is nonetheless a fundamental part of a productive economic base. Of course, manufactured capital is ultimately derived from natural capital, and like knowledge capital, depends upon natural capital for its continued productivity.

Social capital constitutes the stock of social norms, laws and other social institutions that allow individuals to cooperate in the production of economic services. This cooperation of individuals to form a cohesive social network is vital to the pursuit of sustainable development. Some of the most serious threats to the environment around the world stem from social and political breakdown. Even at a less extreme level, the absence of strong political and judicial systems can pose a serious impediment to the functioning of markets and to the design and implementation of effective policy.

Production

Economic capital (natural capital, together with knowledge, manufactured and social capital) provides the inputs into production. Production constitutes the processing (or reconfiguration) of natural capital for the purpose of providing valuable output to satisfy human wants. It is usual to classify production into *sectors*: primary production, manufacturing (or secondary production) and services (or tertiary production). Consider each in turn.

Primary production comprises those activities that are least removed from their natural capital base, including activities such as agriculture, fishing, hunting, forestry, mining, etc. *Manufacturing* applies varying degrees of additional processing to the outputs of primary production to yield a different set of outputs to satisfy different wants. Some of these outputs are used to provide direct services (“final goods”, such as televisions and cars), while others act as inputs into other manufacturing processes (“intermediate goods”, such as lumber and steel bars). Manufacturing typically uses knowledge and manufactured capital more intensively as an input than does primary production. The *service sector* provides direct services both for consumption (such as the entertainment industry) and as an input into production (such as computer programming or the financial

services sector). This sector is typically the most knowledge intensive of the three sectors.

Investment

Part of the output from production is devoted to investment; that is, the maintenance and augmentation of economic capital. Investment is the key to growth: a sustained rate of increase in living standards can only be achieved with sustained growth in economic capital. In the medium term that investment may be appropriately focused on manufactured capital (as it was in industrial countries for most of the past two centuries) but there are limits to the extent to which the stock of manufactured capital can grow, since manufactured capital is simply reconfigured natural capital, and natural capital is limited. Truly long term sustainable development requires investment in the maintenance of natural capital, and in the accumulation of knowledge and social capital; that is, the development of production methods and social structures that are able to generate greater human happiness with less material input.

Consumption

The output from production that is not invested is consumed. It is important to be clear what is meant by the term "consumption" here. It does *not* simply mean the acquisition and devouring of material goods, as the term is often taken to mean in a lay sense. Consumption in the economic sense refers to the utilization of economic capital either directly, as in the case of strolling through a forest, or indirectly through produced goods, to generate *utility* (or happiness). There is no necessary link between the amount of material devoured in consumption and the happiness derived therefrom. Thus, there is no necessary conflict between sustained consumption growth, in the economic sense, and the finite capacity of natural capital. Of course, such a conflict must inevitably arise if increased consumption growth relies too heavily on material throughput relative to the utilization of knowledge and social capital. That is, while sustainable development is feasible, it is by no means guaranteed without the careful management of natural capital.

Environmental Impact

When economic activity reconfigures natural capital to produce valued goods and services, it must also produce environmental impacts: there is a necessary long-term equivalency of material in-flow and material out-flow.[3] Those environmental impacts arise out of both production and consumption according to the stage at which material is released back into the system. The next two sections present an overview of the most important of these impacts.[4]

2.3 The Environmental Effects of Production

The environmental impacts associated with production vary by type and degree across different sectors. This differentiation across sectors, and across industries within sectors, is a key consideration in examining the impact of trade on the environment, since trade can cause dramatic sectoral shits in the distribution of production. The following provides an overview of the main environmental effects of production according to sector type.

2.3-1 Primary Production

The environmental effects of primary production are typically tied quite closely to industry type. It is therefore useful describe those impacts according to the main primary production industries.[5]

Agriculture

- antibiotic resistance: due to excessive use of antibiotics in livestock.
- deforestation: due to land-clearing.

[3] Material temporarily stored as manufactured capital must eventually flow through the system as that manufactured capital depreciates over time. See Chapter 1 for more detail on “materials balance”.
[4] The environmental impact of energy use, which cuts across all sectors of the economy, is discussed separately in Chapter 3. The environmental impacts of urbanization are discussed in Chapter 7.
[5] Impacts for each industry are listed in alphabetical order, rather than in order of importance, which will differ across countries. The list of impacts is not necessarily exhaustive.

- habitat loss: due to displacement of natural species by livestock, land-clearing, and cultivation.
- methane gas emissions: due to enteric fermentation in livestock and vegetative decay in rice paddies.
- noxious weed infiltration: due to over-grazing.
- smoke: due to slash burning and land-clearing.
- soil contamination: saline contamination due to excessive irrigation (which can raise the water table) and aqua-culture; toxic contamination due to excessive pesticide and herbicide use.
- soil degradation: due to poor cultivation and crop rotation practices, over-grazing (especially on marginal lands), and slash burning.
- vegetative diversity loss: due to concentration in specific seed varieties.
- water pollution: elevated biological oxygen demand (BOD) due to animal excrement; eutrification due to phosphate- and nitrogen-rich fertilizer use; toxic contamination due to pesticide and herbicide use.

Fishing

- by-catch impacts: adverse impacts on by-catch populations (including marine mammals).
- stock depletion: due to over-fishing.
- water pollution: due to chemical fishing techniques (such as the use of cyanide).

Forestry

- biological diversity loss: due to single-species tree-farming and loss of old growth.
- soil contamination: due to excessive use of pesticide and herbicides in silviculture.
- soil erosion and landslides: due to road-construction and harvesting in steep terrain.
- stream silting: associated with soil erosion, this is a major cause of flooding and fish habitat loss.
- water pollution: due to pesticide and herbicide run-off, and soil erosion.

Mining, and Oil and Gas Extraction

- air pollution (especially greenhouse gases and volatile organic compounds): due to gas flaring.
- habitat disruption: due to on-site intrusion and to road construction.
- soil contamination: due to spillage.
- water pollution: due to spillage, heavy metal separating agents, and acidification from tailings ponds drainage.

2.3-2 Manufacturing

The environmental effects of manufacturing are less industry-specific than in the primary production sector, and the sources of pollution are much more diverse (although some industries tend to be more pollution-intensive than others). For manufacturing it is therefore more useful to describe the main environmental impacts according to pollution types.

Air Pollution and Water Pollution

Air and water pollutants can be classified according to the degree to which they are uniformly mixed versus non-uniformly mixed, and whether they are dissipative or cumulative:

- *uniformly mixed pollutants* are those that become dispersed uniformly over the receptive region (such as an airshed or a lake). Important examples in the case of air pollution include volatile organic compounds (VOCs) (for example, from fossil fuel processing and combustion, and paints and solvents), and global pollutants such as carbon dioxide (from fossil fuel combustion) and chloroflourocarbons (CFCs) (used as refrigerants, aerosol propellants, and solvents, particularly in the semi-conductor industry).

- *non-uniformly mixed pollutants* tend to pool around sources, and so form “hot spots” within a receptive region. Important examples in the case of air pollution include

suspended particulates (for example, from wood burning and fossil fuel combustion), sulphur dioxide and nitrous oxides (for example, from fossil fuel combustion, especially coal), and radioactive emissions. Most water pollutants tend to be non-uniformly mixed. Important examples include biological oxygen demand sources (such as sewerage wastewater), organochlorines (from pulp and paper production), oil and industrial solvents, and heavy metals.

- *dissipative pollutants* are those whose damaging impact is relatively short lived. They are assimilated reasonably quickly, but not so quickly as to cause no damage. The damage done by these pollutants in any given period is independent of emissions in previous periods. Important examples in the case of air pollution include suspended particulates, VOCs, sulphur dioxide and nitrous oxides. Important examples in the case of water pollution include biological oxygen demand sources, oil and industrial solvents. Dissipative pollutants can be uniformly or non-uniformly mixed.

- *cumulative pollutants* are those that build up in the environment over time. These pollutants are assimilated very slowly, and the damage done by emissions in any given period depends on the volume of emissions in previous periods. Important examples in the case of air pollution include radioactive emissions, lead, carbon dioxide and CFCs. Important examples in the case of water pollution include organochlorines and heavy metals, which tend to accumulate in animal body fats. Cumulative pollutants can be uniformly or non-uniformly mixed.

Whether a particular pollutant is uniformly or non-uniformly mixed depends importantly on the size and physical characteristics of the receptive region (including such factors as weather patterns, marine currents and tidal activity). A pollutant could potentially be uniformly mixed in some instances and non-uniformly mixed in others. Similarly, the distinction between dissipative and cumulative pollutants is somewhat artificial; pollutants of all types fall along a continuous spectrum from those that are rapidly assimilated to those that persist for many years. The classification is nonetheless a useful one for the purposes of designing policy.

Soil and Groundwater Contamination

Associated with industrial sites where toxic waste materials have either been deliberately buried or dumped, or accidentally spilled.

Solid Waste

A significant fraction of sold waste originates from industrial sources (the remainder originating from households). The main environmental impacts stem from transportation of waste to disposal sites, and from the disposal sites themselves (in the case of incineration: air pollution; in the case of landfill disposal: methane gas emissions, groundwater and soil contamination, noxious fumes and land-use loss).

2.3-3 The Service Sector

The service sector is typically less polluting than other sectors, since it is usually more knowledge intensive. Among the most important environmental impacts of this sector are those associated with transportation, particularly urban air and noise pollution. Other types of damage are more industry-specific. For example, the growth of "eco-tourism" in many developing countries has the potential to cause significant habitat damage if not properly regulated.

2.4 The Environmental Effects of Consumption

Since all production is ultimately for the purposes of consumption, the distinction between the environmental effects of production and those of consumption is to some extent artificial. Moreover, consumption can itself be thought of as a stage of production: consumption is essentially a process of *household production,* in which goods are the inputs and the services provided by those goods are the outputs. (For example, the consumption of gasoline can be viewed as the processing of gasoline to produce transportation services). In addition, many of the polluting characteristics of consumption

stem from properties of the products built into them at the production stage. Thus, in many instances environmental impacts associated with consumption are best addressed at the production stage.

However, the distinction between production effects and consumption effects is nonetheless a useful one, especially in a world with trade because goods are often consumed in a country different from the one in which they are produced. Some of the most important sources of consumption-related environmental impacts are:

- air pollution: due to transportation and home energy use (for cooking, heating/cooling and lighting, etc.).
- habitat disruption: due to urbanization.
- solid waste: a major problem in urban areas where land for landfilling is scarce and the effects of incineration pollution are concentrated.
- water pollution: due to wastewater, urban runoff, and chemical contamination from detergent use and household paint and solvent disposal.

Many of the impacts that households have on the environment are associated with energy use and urbanization. These issues are both discussed in detail in Chapters 3 and 7 respectively.

2.5 Environmental Damage and the Role for Policy

Materials balance in the natural system means that economic activity must have an environmental impact. The key to good policy is to ensure that the costs of that impact do not out-weigh the benefits associated with the economic activity that creates that impact. Moreover, the costs associated with a particular pollutant will vary according to specific circumstances. For example, untreated wastewater is much more damaging when it flows into an urban stream than when it flows into a heavily flushed area of ocean. Thus, the

primary concern of policy should be with *environmental damage* (that is, the costs of environmental impacts) rather with environmental impacts *per se*.[6]

Environmental damage manifests itself in a number of important ways, including:

- aesthetic costs;
- damage to the productivity of natural capital;
- human health effects; and
- materials damage.

While each of these effects are important, the second effect has a significant dynamic aspect to it. In particular, continual damage to the productivity of natural capital is not consistent with sustainable development. This does *not* mean that damage to the productivity of natural capital should be avoided at all cost; the benefits derived from the damaging activity must also be taken into account when deciding where an appropriate balance lies. However, it does mean that such damage cannot be allowed to occur indefinitely if sustainable development is to be achieved.

It should also be noted that damage to natural capital can sometimes be reversed if the stresses upon the system are removed. (For example, lakes can sometimes recover from acidification if the flow of acid precipitation is stemmed). This type of recovery can be assisted with deliberate restoration programs, and to this extent, it is possible to invest in natural capital just as it is possible to invest in other forms of economic capital. However, the natural system is an extremely complex one, whose dynamic inter-relationships are still poorly understood. Thus, causing damage to the productivity of natural capital can be a high-risk strategy, and that risk must be taken account when assessing where the balance lies between environmental damage and the benefits of the damaging activity.

[6] This distinguishes an economic approach to policy from a strictly ecological one, which often puts more emphasis on the magnitude of an environmental impact than on whether or not that impact is important for human welfare.

2.6 Synopsis

- The economy draws upon natural capital to produce valuable goods and services, and through the reconfiguration of that natural capital, creates environmental impacts.
- Economic capital constitutes the productive inputs in the economy; it comprises: natural capital, knowledge capital, manufactured capital, and social capital.
- The productivity of knowledge capital, manufactured capital and social capital relies fundamentally on the productivity of natural capital.
- Production constitutes the processing (or reconfiguration) of natural capital for the purpose of providing valuable output to satisfy human wants.
- The main production sectors are primary production, manufacturing, and services.
- Investment is the maintenance and augmentation of economic capital; it is the key to growth.
- Consumption (the utilization of economic capital for generating utility) is the ultimate purpose of production.
- Environmental impact is a necessary consequence of reconfiguring natural capital through economic activity.
- The role for policy is not to prevent all environmental impacts, but to ensure that the right balance is achieved between environmental damage and the benefits derived from the economic activity that generates that impact.

2.7 Related Reading

Grossman, Gene, M. and Alan B. Krueger (1995), "Economic Growth and the Environment", *Quarterly Journal of Economics*, May, 353-377.

Shaw, Daigee, Tsu-Tan Fu, Lung-An Li, Wen-Harn Pan and Jin-Tan Liu (1996), "Acute Health Effects of Major Air Pollutants in Taiwan", in Robert Mendelsohn and Daigee Shaw (eds.), *The Economics of Pollution Control in the Asia Pacific*, Edward Elgar Press, Cheltenham, United Kingdom.

3. Energy Use and the Environment

3.1 Introduction

Every aspect of production and consumption involves the use of energy. The importance of energy to every component of economic activity has spawned more research and debate about energy resources than any other natural resource. Twenty years ago the focus of that debate was on the possibility of near-term critical energy shortages, and predictions of an imminent "energy crisis". The focus of the debate today has shifted more to the environmental impacts of energy use, especially in relation to carbon dioxide emissions from fossil fuel combustion, and the implications for global climate change.

This chapter reviews some of the main issues with respect to energy use and its environmental impacts. We begin with an overview of the current status of energy production and consumption, and a discussion of likely future trends in energy use. We then turn to the environmental impacts of energy use.

3.2 Energy Consumption[1]

Global energy consumption in 1993 (the most recent year for which reliable data is available) was 326 exajoules, which is the equivalent of about 55 billion barrels of oil.[2] This represents an increase of almost 50% over the consumption level twenty years earlier. OECD countries account for around 53% of current energy consumption, while developing countries account for around 29%. Consumption by "transition economies"

[1] The data source for this section and the next is World Resources Institute (1996), *World Resources: A Guide to the Global Environment 1996-97,* Oxford University Press, New York. All data relates to 1993, the latest year for which reliable data is available.

[2] One exajoule is 10^{18} joules.

(the former Soviet Union and the countries of Central Europe) is around 18% of the global total.[3] (See Figure 3.1).

Growth in energy consumption in OECD countries from 1973 to 1993 was around 30%. In comparison, growth in energy consumption in developing countries over the same period was almost 300% (albeit from a much lower base). Much of the absolute growth in energy consumption in developing countries has been in Asia, although percentage growth rates in Latin America and Africa were also very high (in excess of 200%).[4]

3.3 Energy Production

The pattern of energy production is markedly different from the pattern of energy consumption. In particular, OECD countries account for only 38% of production, while developing countries account for 43%. Transition countries account for around 19%. (See Figure 3.2). These numbers reflect the importance of oil exports from many developing countries, especially in the Middle East.

Energy sources can be classified into two types: "traditional fuels" and "commercial energy sources". Traditional fuels include fuelwood, charcoal, bagasse, and animal and vegetable wastes. These fuels account for only around 6% of global energy production, but they are much more important in many developing countries. In Africa, the share for traditional fuels is around 35%, and in some Sub-Saharan countries, that share is over 75%. In Latin America and Asia (excluding Japan), the shares for traditional fuels are around 21% and 10% respectively. (See Figure 3.3).

[3] The member countries of the OECD (Organization for Economic Co-Operation and Development) are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico (since 1994), the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. "Developing countries" includes all non-OECD countries, excluding the transition economies.

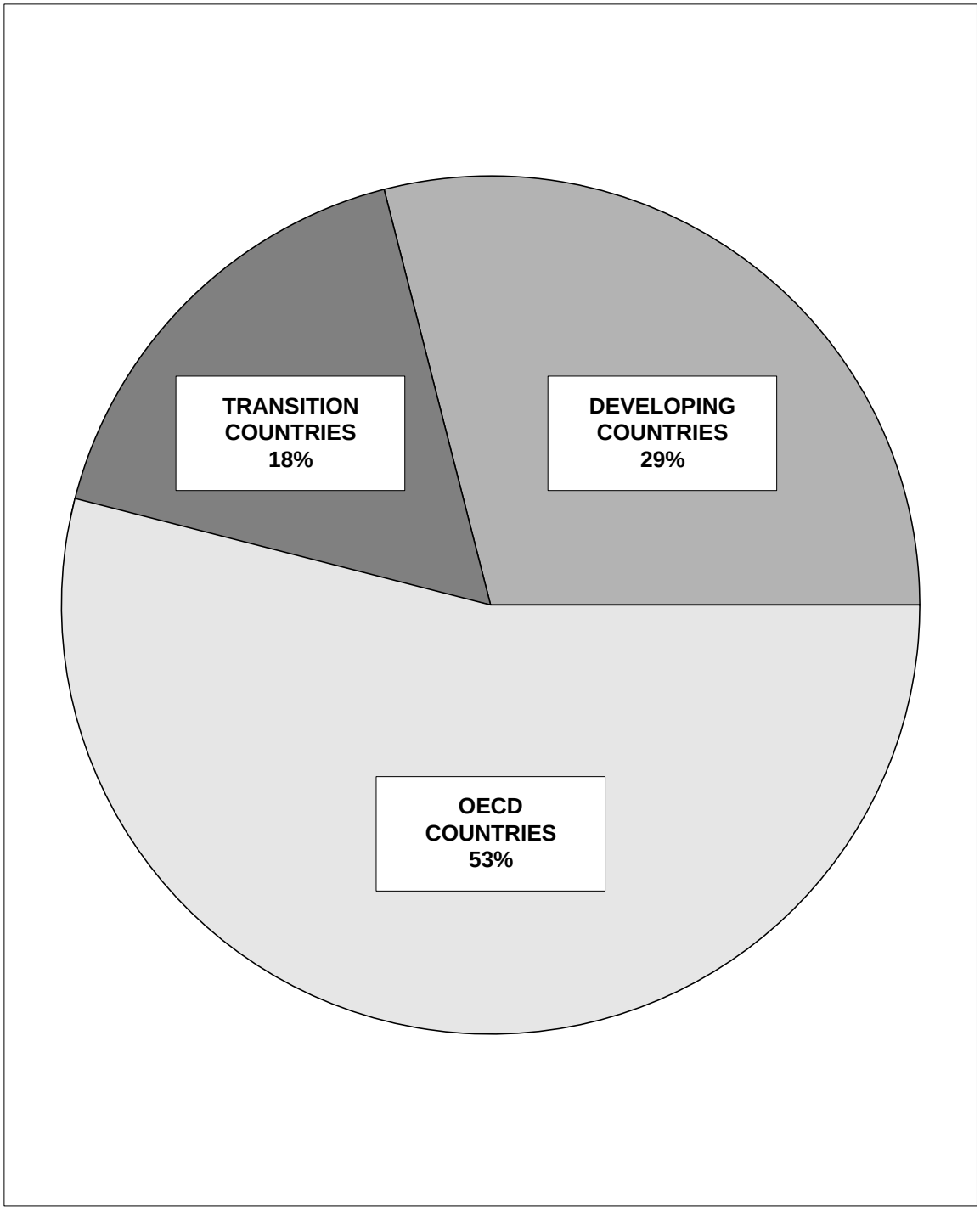

Figure 3.1

Shares of Global Energy Consumption (1993)

[4] Growth in energy consumption in the transition economies was substantial up to 1989 but has since fallen dramatically, in concert with industrial production.

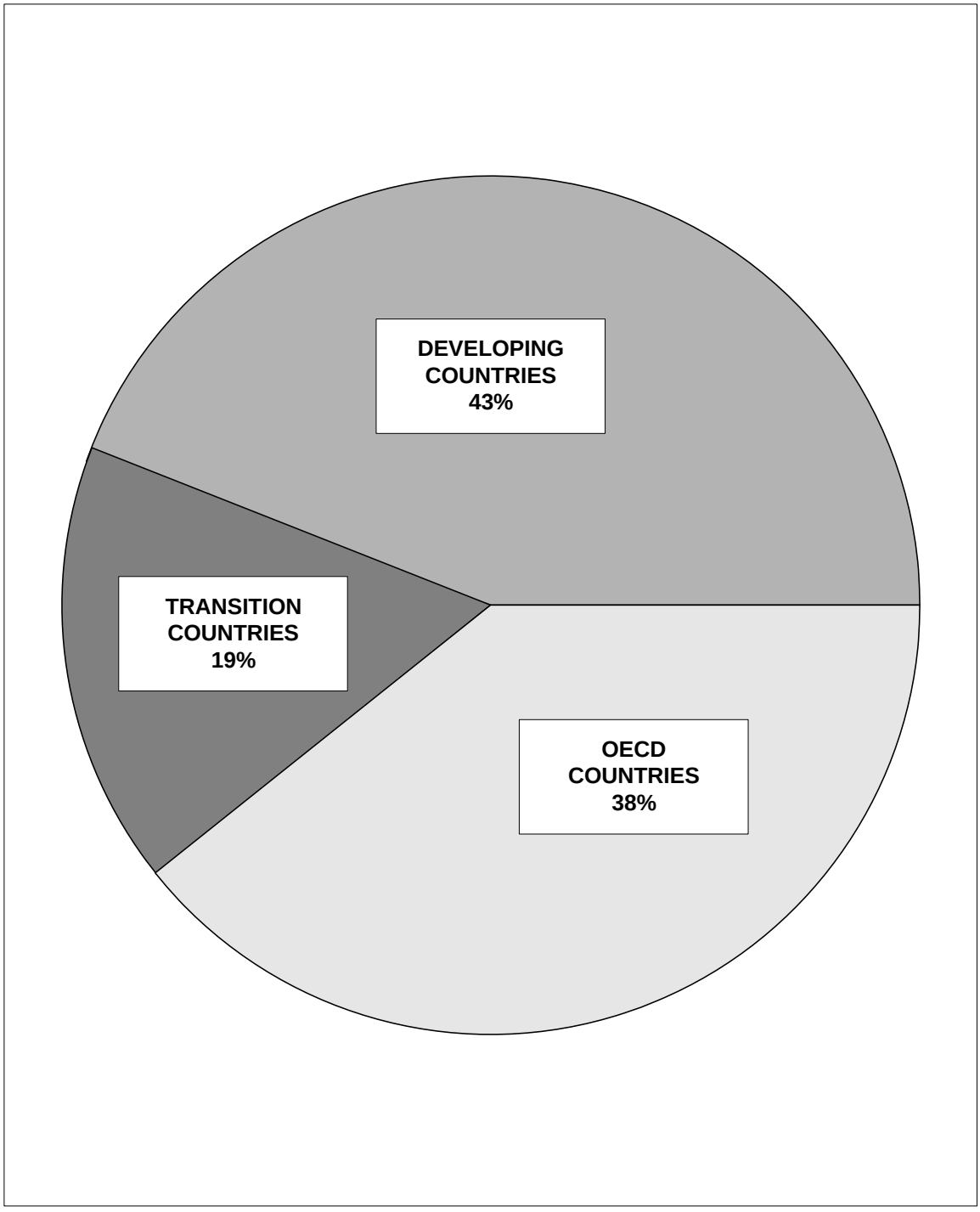

Figure 3.2

Shares of Global Energy Production (1993)

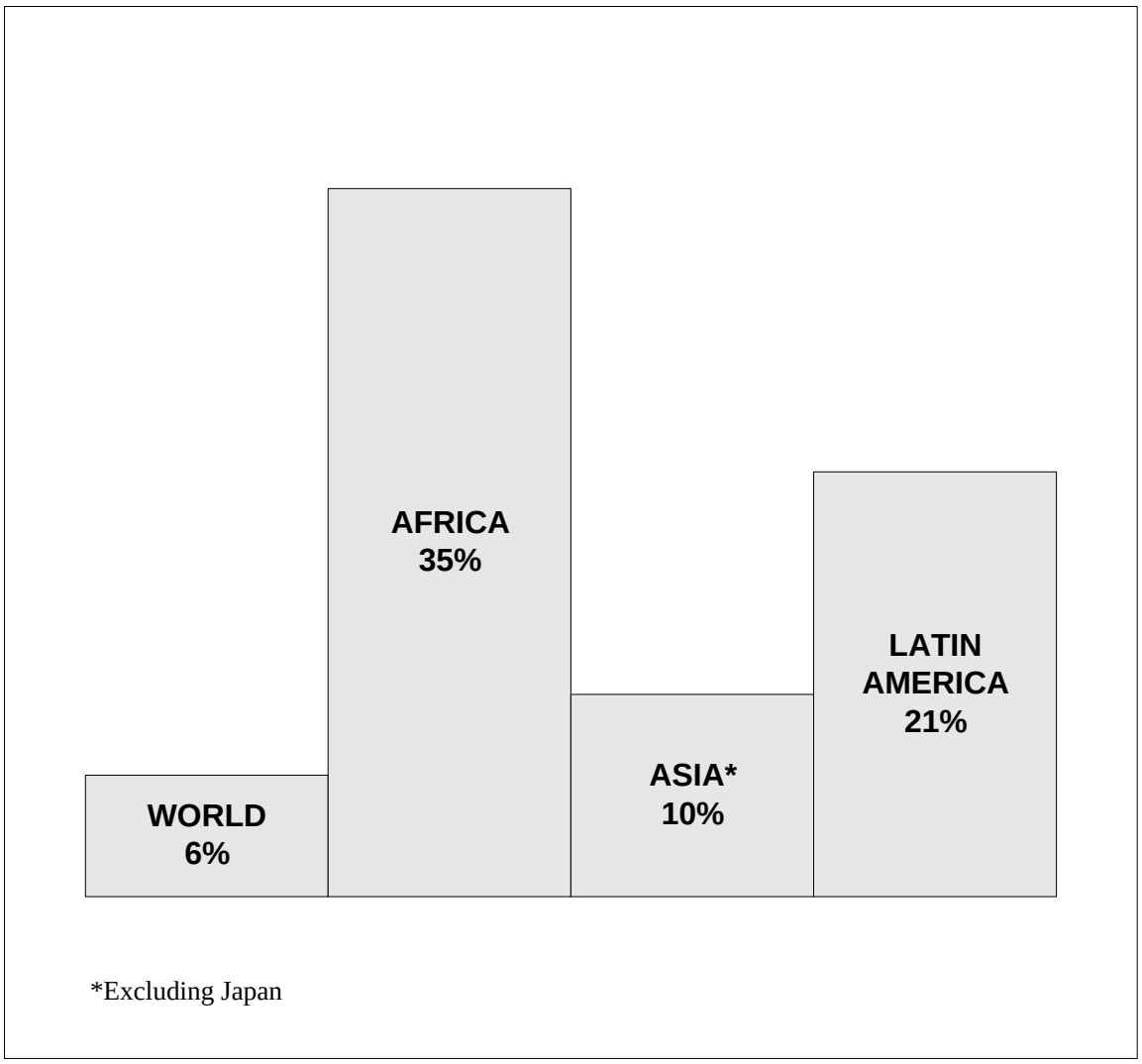

Figure 3.3

Share of Traditional Fuels in Total Energy Production (1993)

The main commercial energy sources include:

- petroleum;
- solid fossil fuels;
- natural gas;
- nuclear power;
- hydroelectric generation; and
- other sources (such as geothermal, wind and solar power).

The relative importance of these sources is illustrated in Figure 3.4.

Petroleum

Petroleum accounts for 40% of the world's commercial energy production. Estimates of global petroleum reserves have remained roughly constant since 1989 (new discoveries and re-evaluations having kept pace with consumption), and at current consumption rates, would last another 40 years (assuming no new discoveries or re-evaluations). Approximately 65% of those reserves are located in the Middle East.

Solid Fossil Fuels

Solid fossil fuels (such as coal, lignite and peat) make up 27% of global commercial energy production. Estimated reserves would last at least 200 years at current consumption rates.

Natural Gas

Natural gas accounts for 23% of global commercial energy production (compared with a 20% share twenty years earlier). Current estimated reserves would last about 60 years at current consumption rates, but estimated reserves have increased dramatically over the past decade, and new discoveries and re-evaluations are likely to continue to outpace consumption for some time to come.

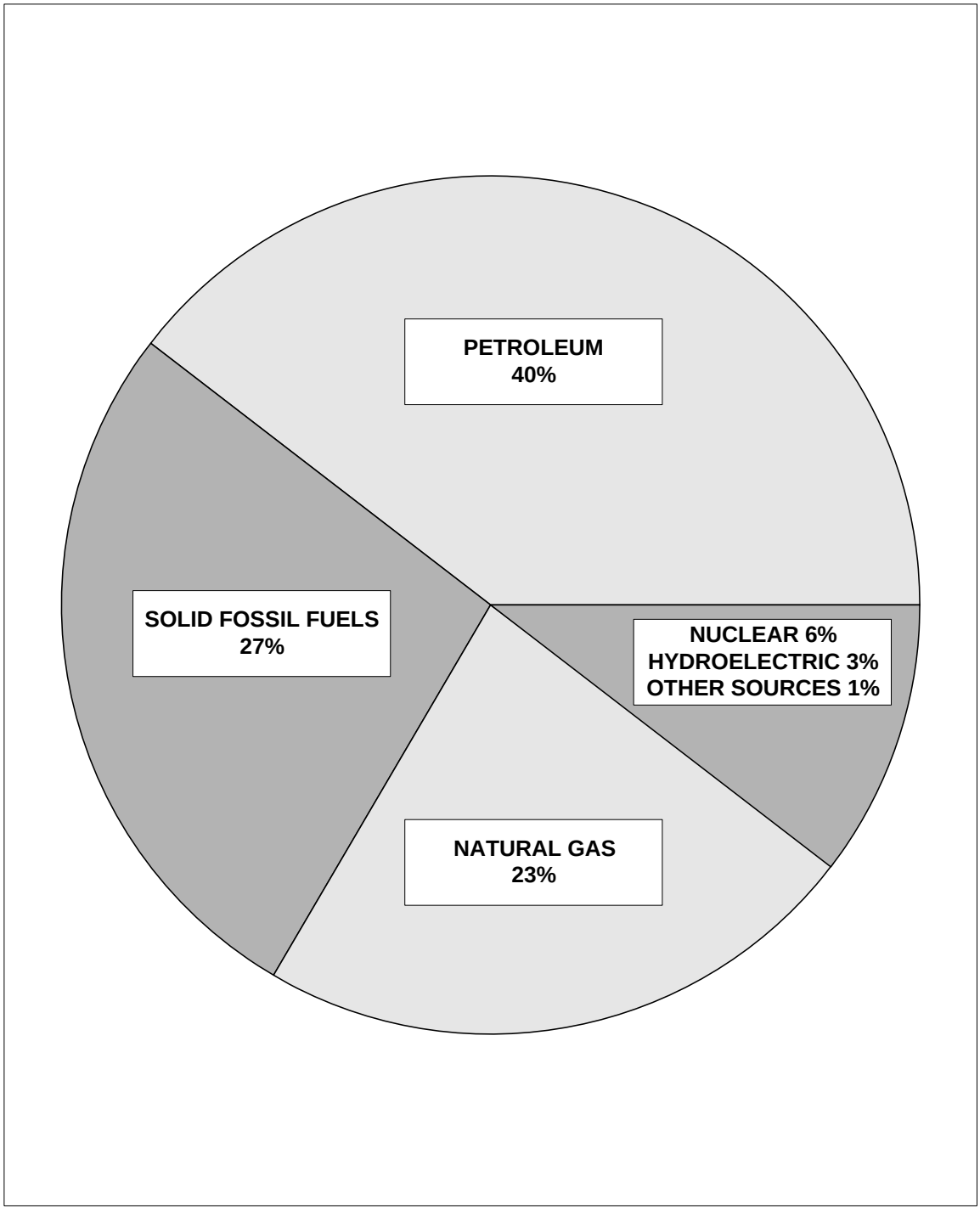

Figure 3.4

Sources of Energy Production (1993)

Nuclear Power

Nuclear power makes up about 6% of commercial energy production. Current estimated uranium reserves would last about 40 years at current consumption rates.

Hydroelectric Generation

Hydroelectric generation accounts for only about 3% of total energy production, although it is much more important in some countries, such as Canada. There are no reliable estimates of global hydroelectric generating potential, although some countries, especially Brazil, China and Russia, are thought to have significant remaining potential.

Other Energy Sources

Geothermal power, wind power, solar power and tidal power contribute only about 1% to commercial energy production. Renewable transportation fuels, such as ethanol and biodiesel (produced from crops), account for an additional but tiny fraction of energy production.

3.4 Future Trends in Energy Production and Consumption

Forecasting global energy demand is notoriously difficult, due to uncertainty about economic growth rates, population growth rates, technological advances, prices, and importantly, government policy. Indeed, from a policy perspective, it is entirely inappropriate to fix on a particular energy demand estimate and design policy simply as a reaction to that forecast. Policy should instead be pro-active in shaping energy demand as part of a strategy towards achieving more fundamental goals. Nonetheless, forecasts based on passive policy are useful as an indicator of the degree to which pro-active policy is needed.

An approximate average of the projections from the main forecasting groups has the following key elements:[5]

- an increase in global energy demand of around 50% for the period 1990-2020;
- increases in energy demand in Asia and Latin America of 200% and 65% respectively, over the same period;
- an increase in the demand share from non-OECD countries to over 50% by 2020 (from 47% in 1993 and about 33% in 1970);
- the increased demand for energy will be met by increases in all existing supply sources, with petroleum remaining dominant; and
- the share of natural gas and renewable energy sources will increase at the expense of petroleum and coal, but fossil fuels will still supply at least 75% of energy needs by 2020.

3.5 The Environmental Impact of Energy Use

The environmental impacts of energy use vary widely according to the source from which the energy is produced. In this section we briefly review the most significant environmental impacts associated with the main energy sources.

Fossil Fuels and Other Carbon-Based Fuels

- *Atmospheric particulates.* Smoke and other atmospheric particulate matter is a major cause of respiratory illness and death, particularly in urban areas. The combustion of fuelwood, charcoal, coal and diesel fuel are among the main sources of these pollutants.
- *Carbon dioxide emissions.* Carbon dioxide, produced by the combustion of carbon-based fuels, is the single most important greenhouse gas, and its implications for global climate change probably constitute the most serious set of environmental impacts associated with any energy source.

[5] Those groups are The World Energy Council (see website *www.wec.co.uk/index.htm*). the International Energy Agency (*www.osti.gov/html/osti/etde/annual/iea.htm*) and the U.S. Department of Energy

- *Carbon monoxide*. This gas is produced by the imperfect combustion of fossil fuels, particularly from automobiles. It causes headaches and lethargy, and in concentrated doses, unconsciousness and death.
- *Coal ash*. Coal ash (especially from low temperature combustion) contains a large number of toxic and carcinogenic compounds. Fly ash is serious air pollutant, and the disposal of coal ash can be a serious cause of soil and water contamination.
- *Deforestation*. The collection of fuelwood in many developing countries is a significant contributor to deforestation.
- *Foregone land use*. Renewable biomass fuels, such as ethanol, would require vast areas of land devoted to crops if produced on a large scale.
- *Lead*. The ingestion of atmospheric lead, principally from the combustion of leaded gasoline in automobiles, can cause severe mental development retardation in children.
- *Methane gas*. Methane (the primary component of natural gas) is a significant greenhouse gas and a suspected carcinogen. Methane is released during the capture, transportation and incomplete combustion of natural gas.
- *Oil spills*. The spillage of oil, both on water and on land, is a major source of marine and land ecosystem degradation. The main causes of oil spills are tanker accidents, pipeline and storage tank failures, and well-head spillage.
- *Sulfur dioxide and nitrous oxides*. These atmospheric compounds cause the acidification of precipitation, which causes damage to marine ecosystems, forests, crops, buildings and other materials. Nitrous oxides also act as catalysts in the formation of tropospheric (ground level) ozone, which can cause severe eye and respiratory irritation, and damage to forests, crops and materials. The combustion of coal (especially high sulfur coal), oil and diesel fuel are among the main contributors to atmospheric sulfur dioxide and nitrous oxides.
- *Volatile organic compounds* (VOCs). This term refers to a large group of carbon-based vapors that are released during the transportation, transfer and combustion of petroleum products and natural gas. They are known carcinogens and are also catalysts in the formation of tropospheric ozone.

(*www.ost.gov/html/home.html*).

Nuclear Power

Electricity production by the nuclear fission of uranium has a number of well-known environmental risks. The three most important are associated with:

- the short-term and long-term storage of highly radioactive spent fuel;
- the disposal of contaminated coolants and other materials after reactor decommissioning; and
- reactor core breach accidents (such as the Chernobyl accident).

In each case the primary danger is exposure to radioactivity, which is known to cause illness and death, and long-term genetic damage even in small exposure doses.

Hydroelectric Generation

Hydroelectric power is often billed as "clean energy" because it is free of atmospheric emissions and dangerous waste products. However, the large scale flooding that usually accompanies hydroelectric generation nonetheless has some significant environmental impacts. Chief among them are:

- deforestation;
- foregone land use;
- habitat loss (for both fish and wildlife);
- mercury contamination associated with leaching from flooded soils and rocks; and
- population displacement.

Alternative Energy Sources

Alternative energy sources, such as solar power, wind power, tidal power and geothermal power, are generally hailed as having substantially smaller environmental impacts than other fuel sources, but to some extent this simply reflects the small scale on which these energy sources currently contribute to total energy production. For example, producing electricity on a large scale using wind turbines would require the devotion of vast amounts of land to "wind farms". Similarly, the energy requirements for the manufacture of photovoltaic cells (for solar power production) with existing technologies is such that

the *net* energy production from solar power is much less than it appears. Nonetheless, these alternative energy sources do hold considerable promise, at least as transition fuels until more viable sources are found, and are likely to yield greater benefits as their underlying technologies continue to advance.

3.6 Synopsis

- Global energy consumption in 1993 was the equivalent of 55 billion barrels of oil, an increase of 50% from 1973.
- OECD countries account for more than half the global energy consumption; developing countries account for less than one-third. Transition economies account for the remainder.
- Growth rates in energy consumption over the last twenty years have been roughly ten times higher in developing countries than in OECD countries (though the base in developing countries is much smaller). Much of that growth has occurred in Asia.
- Developing countries account for a larger share of global energy production (43%) than OECD countries (38%), reflecting the importance of energy resource exports from developing countries.
- Traditional fuels account for only a small fraction of global energy production but they are much more important in developing countries, especially in Sub-Saharan Africa.
- Petroleum is the most important commercial energy source, followed by solid fossil fuels (principally coal), natural gas, nuclear power and hydroelectric generation.
- Forecasts for energy use to 2010 predict continued substantial growth, especially in developing countries, and a continuing reliance on fossil fuels.
- The primary environmental impact of carbon-based fuel use is the production of carbon-dioxide and its effect on the global climate. Other environmental impacts relate to local air quality, soil and water contamination, and precipitation acidification.

- The main environmental impact of nuclear power relates to the risk of radioactive substance release.
- Hydroelectric generation has few environmental impacts associated with operation but the large-scale flooding associated with project construction has significant environmental costs.

3.7 Related Reading

World Resources Institute (1996), "Energy and Materials", Chapter 12 in *World Resources: A Guide to the Global Environment 1996-97,* Oxford University Press, New York.

4. Trade Liberalization and Multilateralism

4.1 Introduction

The problem of ensuring sustainable development in a global economy is a complex one. Trade and investment flows between countries, together with transboundary environmental impacts, create a web of international linkages between national economies and national environments. In this chapter we focus on international trade and investment. We begin with a basic discussion of how international trade and investment alters the flow of resources within a national economy. We then discuss the potential costs and benefits of trade liberalization. We conclude with a discussion of the distinction between coordination and uniformity in the design of multilateral agreements to support trade liberalization, and some general remarks about trade liberalization and sustainable development.

4.2 International Trade and Investment Flows

The basic framework for our discussion is illustrated in Figure 4.1. There are two key components to international trade and investment flows:

- international investment; and
- exports and imports.

International Investment

International investment refers to the flow of economic capital between countries. We use the term “international investment” here somewhat more broadly than it is sometimes

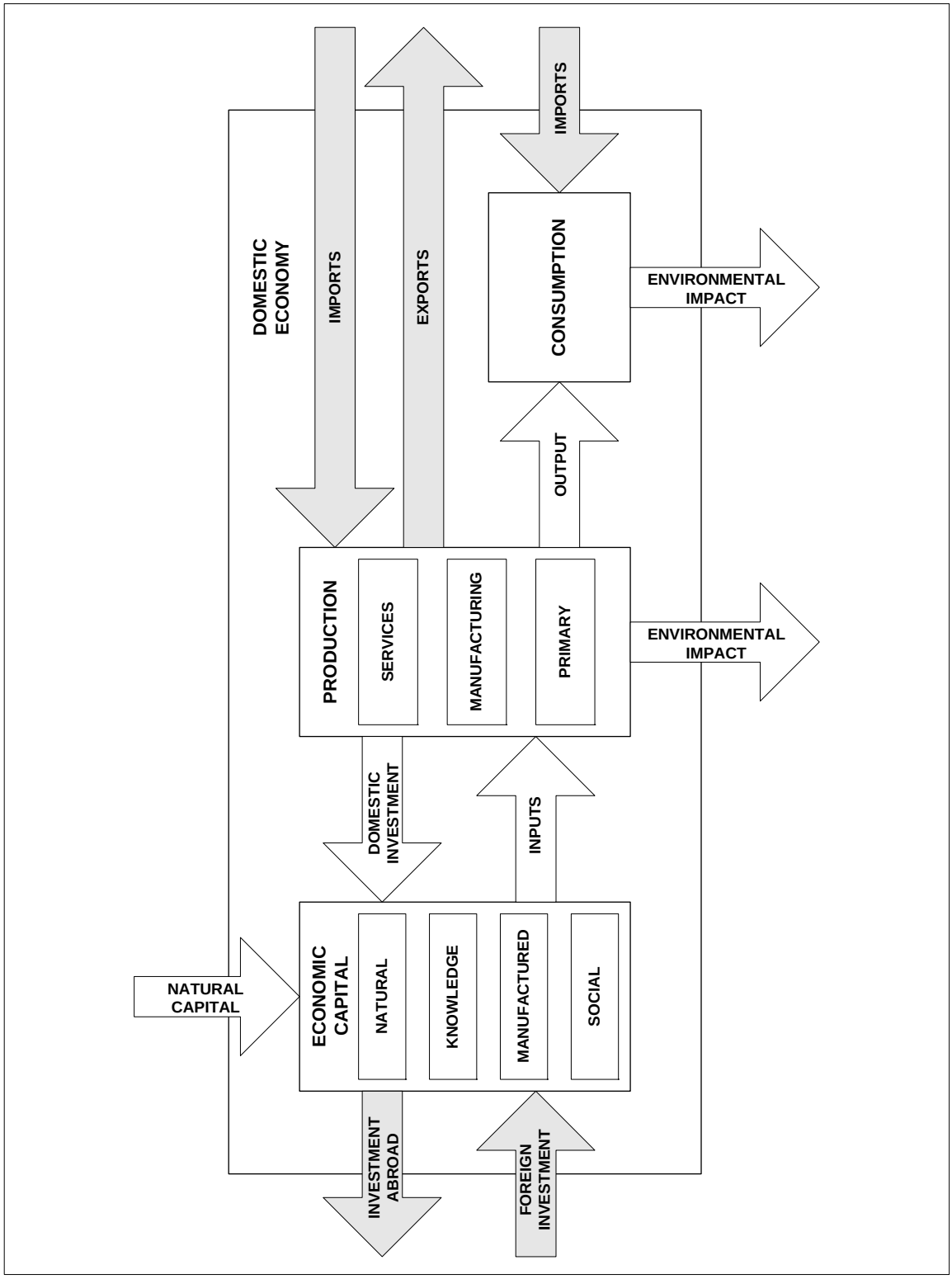

Figure 4.1

International Trade and Investment Flows and the Domestic Economy

used in the financial community. In particular, international investment represents any cross-country exchange of the four categories of economic capital: natural capital, knowledge capital, manufactured capital, and social capital.[1] *Foreign investment* in Figure 4.1 represents the augmentation of the domestic stock of economic capital from foreign countries. *Investment abroad* in Figure 4.1 is simply the reverse of foreign investment: the augmentation of foreign economic capital with resources from the domestic country.

International investment flows in natural capital refers to the transfer between countries of raw natural resources such as water, unprocessed ore, oil and timber. The flow of human labor from one country to another is also a form of international investment.

International investment flows in manufactured capital refers to the transfer of resources for the construction of infrastructure, buildings and equipment, or the direct importation of those items. International investment may be either *indirect*, where financial investment by foreigners in domestic firms provides the funding for the physical investment, or *direct*, where foreign firms construct plant and equipment in the domestic country. In both cases there is a transfer of real resources between countries.

International investment flows in knowledge capital refers to the transfer of knowledge and skills. This is a particularly important element of international investment for developing countries since increased knowledge holds the key to long term sustainable development.[2] Transfers in knowledge are often called “technology transfers”, but it is important to distinguish between the transfer of physical equipment that embodies knowledge, and the transfer of knowledge *per se*. Of course, the two are closely related. In particular, the transfer of goods and equipment can often lead to the incidental transfer of knowledge. This transfer may be intentional or it may constitute an unintentional “spillover”. For example, “reverse engineering” of imported equipment refers to the process of dismantling that equipment in order to learn how it works and how it is built.

[1] See Chapter 2 for more detail on the elements of economic capital.
[2] See the discussion in Chapter 1 (section 1.1).

The associated transfer of knowledge is a spillover from the transfer of the physical equipment. While such spillovers may appear to be a bonus to the transferee, their existence, and the related difficulty of protecting property rights on knowledge and ideas, can actually constitute a barrier to the transfer of knowledge across countries. In particular, the owners of proprietary knowledge may be reluctant to engage in a mutually beneficial sale of that knowledge because the transferee cannot guarantee the containment of that knowledge to the legitimate buyer.[3]

International investment also has an important role to play in the augmentation of social capital: countries can learn a great deal from each other about the design of institutions for organizing economic activity. For example, the adoption of international copyright and patent laws can reduce the potential for knowledge spillovers, and thereby reduce the barriers to knowledge transfers. Similarly, if the regulatory framework for pollution control in one country is superior to that in another country, then both countries can potentially benefit from the transfer of that social capital (especially if pollution is transboundary).

Exports and Imports

Exports and imports refer to the transfer of goods and services between countries. As indicated in Figure 4.1, imports may either take the form of "final goods" for direct consumption, or "intermediate goods" for use as inputs in domestic production. Similarly, exports may be used in the importing country for direct consumption or as inputs into further production.

It is important to recognize that the flow of goods between countries causes a geographical and jurisdictional separation between production and consumption. In particular, the material embodied in imported goods is released through consumption into the environment of the importing country, rather than the environment of the producing country. Similarly, the environmental impacts of production in a given country may not

[3] See Chapter 9 for further discussion of technology transfer.

be closely linked to the types of goods consumed in that country. This means that the materials balance between natural capital utilization and environmental impact that holds at the global environment level need not hold at the level of individual country environments. This necessitates thinking about sustainable development in global terms.

4.3 The Benefits and Costs of Trade Liberalization

At first blush it may appear that the separation of production and consumption associated with international trade necessarily renders the attainment of sustainable development more difficult. However, a closer examination of the issue reveals that this need not be the case. Trade liberalization and multilateralism can be a positive force for sustainable development if policies are designed properly to capture the full benefits of trade and limit its potential costs. This section provides an overview of those benefits and potential costs.

4.3-1 Gains from Trade

The Basis for Trade

It is a fundamental tenet of economic theory that trade is good: trade allows the cooperative exchange of ideas, goods and services to the mutual benefit of both partners in the trade. The main basis for trade is *heterogeneity* across trading partners with respect to economic capital.[4] There are two basic sources of that heterogeneity:

- historical differences in natural capital endowments; and
- economies of scale and scope in production.

Historical differences in natural capital endowments ultimately account for much of the existing heterogeneity across countries. Most early trade reflected simple differences in climate and soil conditions across countries, and modern trade in raw materials still derives principally from differences in natural resource stocks. Over time, differences in

[4] Cross-country differences in tastes and economic policies are additional bases for trade but they are generally far less important.

natural capital endowments gradually induced differences in the development of other forms of economic capital. (For example, that industrialization initially began in the north is thought to ultimately reflect the relatively cold climate there). Those differences in economic capital became magnified over time as initially small degrees of divergence in the evolution of economic capital precipitated progressively larger degrees of divergence. Trade itself was of course a key factor in that precipitation: s*pecialization* in production according to comparative advantage, based on economic capital differences, reinforced those differences over time.

Economies of scale and scope in production is the second basic source of heterogeneity. "Economies of scale" means that unit production costs fall as the level of production increases. At the static level, economies of scale derive from the existence of fixed costs, including expenditures on research and development, and from the physical characteristics of production processes, such as the more-than-proportionate relationship between the surface area and capacity of a pipeline. Economies of scale at the dynamic level reflect *learning-by-doing*: production costs fall over time as more experience is gained. "Economies of scope" means that the unit production cost of one product is lower if another product is produced in conjunction with it. For example, there are economies of scope in the production of gasoline and jet fuel because they can both be produced using the same refining process.

There are two elements to the importance of economies of scale and scope. First, economies of scale and scope helped to amplify and maintain the cross-country divergence in the historical evolution of economic capital. For example, the origination of the steam engine in Britain may be ultimately attributable to the climatic conditions of the north, but the fact that the technology was not immediately adopted in other parts of Europe is largely attributable to the benefits of learning-by-doing that accrue to the *technological leader*. The persistence of economic capital differences today is also due in part to economies of scale and scope, since they effectively act as *barriers to entry* to would-be investors in a large range of industries.

The second element to the importance of economies of scale and scope relates closely to the first. The barriers to entry associated with economies of scale and scope lead to *imperfect competition* in production. That is, production tends to be dominated by a small number of large firms. Indeed, much of the current global trade in industrial products comprises cross-country sales by large multinational corporations, and a key aspect of globalization is the increasing dominance of these global firms in production and trade. (The potential cost of this concentration is discussed in section 4.3-2).

The Benefits of Trade

The benefits of trade stem from four main sources:

- the direct exchange of economic capital;
- specialization in production;
- the exploitation of economies of scale and scope; and
- competitive pressure.

Trade at its simplest involves the *direct exchange of economic capital*.[5] A country with a relative abundance of one type of economic capital can benefit from an exchange with another country possessing a relative abundance of a different type of capital because production usually requires a mix of capital types. Thus, both countries are able to produce and consume more by sharing their economic capital. This type of exchange is the essence of international investment.

The direct exchange of economic capital can often be prohibitively costly. An alternative way for two countries to effectively share their economic capital is to do so indirectly, though the exchange of produced goods. Each country can *specialize* in the production of goods to which its economic capital is best suited. For example, a country that has a relative abundance of knowledge capital but is relatively poor in natural capital can specialize in the production of knowledge capital-intensive goods and trade those goods

[5] This is sometimes called “pure exchange” to distinguish it from trade in produced goods.

with a country whose comparative advantage lies in the production of natural-capital intensive goods. Both countries benefit from the effective sharing of economic capital.

Trade also allows the better *exploitation of economies of scale and scope*. By selling to a large global market firms are more able to produce at volumes where unit costs are lower than if they were producing solely for a small domestic market. This means that fewer resources are required to achieve a given level of production. Moreover, to the extent that large global firms are better able to spread the costs of research and development, trade potentially fosters greater innovation.

The exploitation of economies of scale and scope at the level of a small domestic market may require a high level of concentration in the industry (that is, a small number of firms producing a large share of total output). At the extreme, there may exist a "natural monopoly" relative to the market size, where unit production costs are lowest if all production is undertaken by a single firm. This degree of concentration can lead to over-pricing and under-production relative to what social costs and benefits dictate. These distortions can be magnified if the concentration leads to collusion between firms. Trade allows the pressure of *foreign competition* to moderate these distortions. The competitive pressure can also serve to foster innovation; creating the right incentives to undertake research and development requires a balance of concentration (to allow the absorption of the associated fixed costs) and competition (to prevent firms from stagnating).

4.3-2 The Costs of Trade Liberalization

There are two main sources of costs that can accompany trade liberalization:

- structural adjustment; and
- strategic distortion of policy.

These are discussed in detail in Chapters 6 and 8 respectively, so only a brief overview is presented here.

Structural adjustment refers to the substitution and displacement that accompany the shifts in consumption and production patterns associated with trade liberalization. These adverse effects of trade are inevitable since the benefits of trade stem directly from the shifts in consumption and production patterns. For example, specialization in production inevitably means that some industries must decline relative to others. This imposes costs on those people whose livelihoods are tied to the declining industry. There is a role for policy to manage this adjustment and to ensure that the costs of the adjustment do not fall too heavily on any single group.

The potential for the *strategic distortion of policy* in response to trade liberalization is tied to industry concentration and the associated existence of *rents* (above-normal profits) to imperfectly competitive firms. In particular, a country may be tempted to distort its domestic policies in order to boost the global market share of the firms based there, and thereby capture a greater share of the associated rents. This has the potential to induce a destructive global "race to the bottom" in the setting of environmental standards, and other instruments of social and economic policy. Careful multilateral coordination is needed to guard against this.

4.4 Coordination vs. Uniformity in Multilateral Agreements

Global trade liberalization is increasingly supported by a wide range of multilateral agreements between countries. Foremost among these is the World Trade Organization. These multilateral agreements, and related international treaties and conventions, provide a mechanism for the *coordination* of standards and policies of all signatory countries. This international coordination is one of the most positive aspects of globalization. It is a well-established principle of economics that more coordination is always better than less.

However, the differences between countries that give rise to the gains from trade also mean that coordination should not necessarily involve complete *uniformity* across countries. Multilateral agreements should allow different countries to establish different

standards and set different policies according to their specific characteristics. The coordination of different standards and policies does not require that those standards and policies be the same across countries. The key to successful multilateralism is cooperation and coordination, not uniformity.

4.5 Trade Liberalization and Sustainable Development

Trade liberalization has both benefits and costs. On balance, the benefits will outweigh the costs under most circumstances, but good policy is needed to ensure that. In particular, well-designed domestic policies, together with multilateral policy across countries, can ensure that the net benefits of trade liberalization are positive. This need for good policy design is particularly true with respect to the environment. Trade liberalization has the potential to be a positive force for global sustainable development: the production efficiencies associated with trade means that goods can be produced with fewer resources, and this can translate directly into a smaller environmental impact for a given level of consumption. However, the effects of trade on the environment, and the setting of environmental policy, must be carefully managed in order for that positive potential to be realized. The remaining chapters in this course focus on the details of the links between trade and the environment, and on the design of appropriate policies for the marriage of trade liberalization and sustainable development.

4.6 Synopsis

- There are two key components to international trade and investment flows: international investment, and exports and imports.
- International investment refers to the flow of economic capital (natural capital, knowledge capital, manufactured capital and social capital) between countries; it may be either direct or indirect.

- Export and imports refer to the transfer of goods and services, and may involve final goods (for consumption) or intermediate goods (for input into production).
- The basis for trade is heterogeneity across countries, especially with respect to economic capital stocks.
- The two basic sources of heterogeneity are historical differences in natural capital endowments, and economies of scale and scope in production.
- The benefits of trade stem from four main sources: the direct exchange of economic capital; specialization in production; the exploitation of economies of scale and scope; and competitive pressure.
- The potential costs of trade liberalization stem from structural adjustment, and strategic policy distortion.
- The international coordination of standards and policies is one of the most positive aspects of globalization, but this does not necessarily mean that standards and policies should be uniform across countries.

4.7 Related Reading

Jesdapipat, Sitanon (1997), "Trade, Investment, and the Environment: Thailand", *Journal of Environment & Development*, 6, 350-360.

Spalding, Mark J. (1997), "Lessons of NAFTA for APEC", *Journal of Environment & Development*, 6, 252-275.

5. Scale, Technique and Composition Effects of Trade on the Environment

5.1 Introduction

Trade liberalization can have a dramatic effect on the volume and composition of resource flows through the economy. These changes can in turn have a significant impact on environmental quality. Our purpose in this chapter is to examine the key channels through which that impact occurs. There are three such channels:

- a scale effect;
- a technique effect; and
- a composition effect.

We first discuss each of these effects in turn, and then discuss the likely net effect of trade on the environment.

5.2 The Scale Effect of Trade

Trade has the potential to benefit all parties involved by exploiting comparative advantage due to differences between them in the composition of economic capital stocks, and through the exploitation of economies of scale and scope. That benefit manifests itself as increased production and consumption. This is illustrated in Figure 5.1. The level of production and consumption expands in both countries after trade. All other things equal, this necessarily translates into an increased throughput of material and a consequent increase in environmental impact. That is, the trade-induced increase in the *scale* of production and consumption causes an increase in the scale of environmental impact.

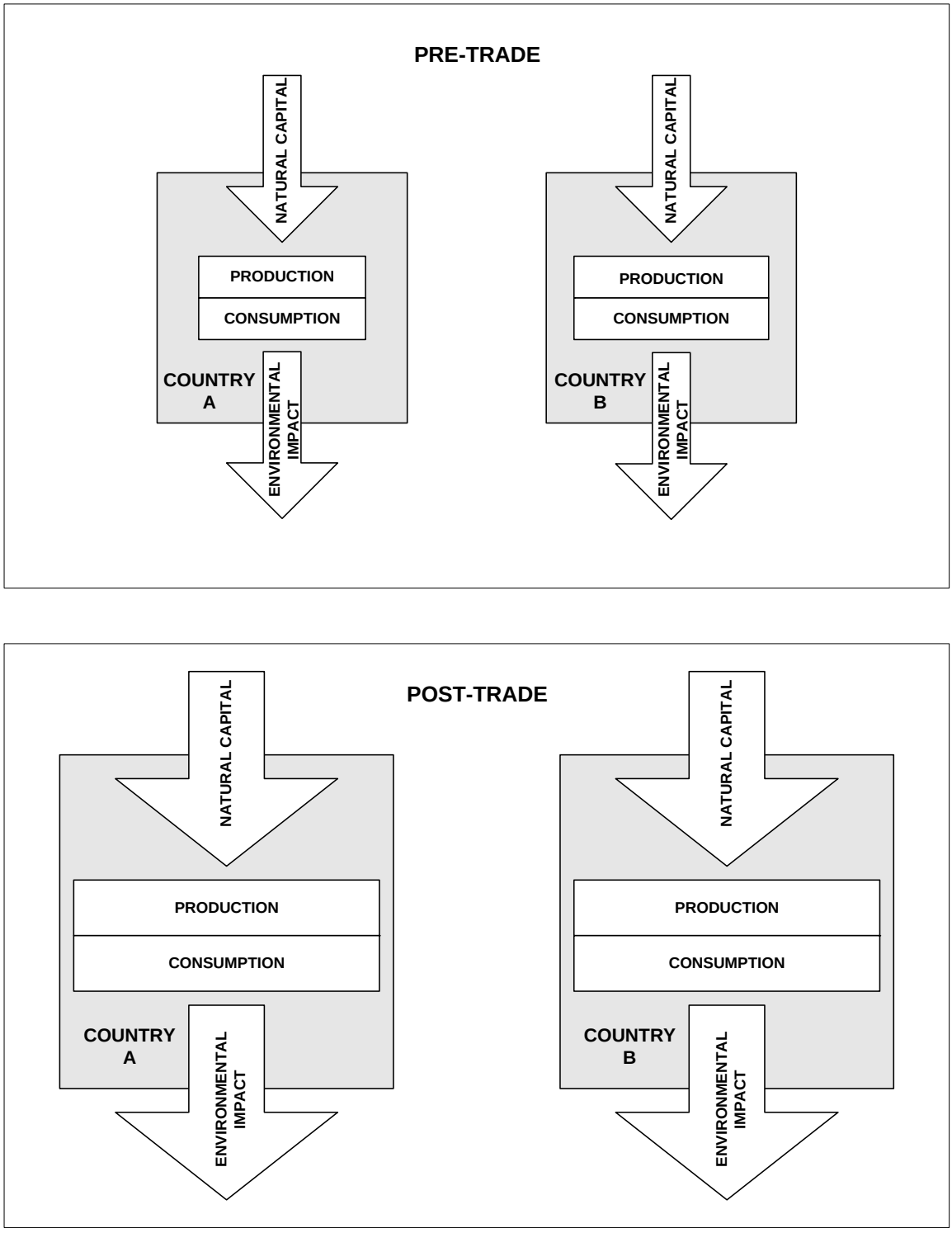

Figure 5.1

The Scale Effect of Trade

A particularly important element of the scale effect of trade is the growth in the demand for energy. For example, much of the growth in South-East Asian countries over the past twenty years can be directly attributed to trade liberalization in the region. That growth has in turn led to a vast increase in the consumption of energy, and in the consumption of fossil fuels in particular, with an accompanying increase in the volume of carbon dioxide emissions. Similarly, the predicted growth in the Chinese economy over the next twenty years, much of it trade-induced, will translate into significant increases in carbon dioxide emissions. Other examples from developing countries abound, including the level of urban auto emissions, solid waste volumes, and emissions of industrial toxins.

The scale effect is perhaps the most obvious effect of trade on environmental quality, and it is one that has caused considerable concern among those who see trade as a negative influence on the global environment. There is no doubt that, all other things equal, a trade-induced increase in the level of global production and consumption must cause an increase in the throughput of materials, and an associated impact on the environment. However, all other things will generally not be equal. In particular, the technique effect of trade can potentially offset the negative impact of increased scale.

5.3 The Technique Effect of Trade

The increase in wealth that accompanies an expansion of trade is likely to induce an increased demand for environmental quality. Most empirical evidence indicates that environmental quality is a so-called “normal good”; that is, a good whose demand increases with wealth. This increase in the demand for improved environmental quality has the potential to put market pressure on industry to improve its environmental performance, and political pressure on governments to tighten their environmental policy standards. Those improvements are achieved not through a reduction in production volumes, but rather through the adoption of cleaner *production techniques*. In terms of aggregate resources flows, this represents a substitution out of *natural capital* utilization into *knowledge capital* utilization (that is, a shift into better “technology”).

The technique effect is illustrated in Figure 5.2. Both countries, having become wealthier through trade, switch out of natural capital and into knowledge capital, and for a given scale of production, have a smaller impact on the environment; that is, the throughput of material in the natural system is reduced.

The technique effect of trade holds the key to the fostering of sustainable development through trade liberalization. The substitution of knowledge capital for natural capital is a positive force for the environment, and has the potential to offset, and perhaps even more-than-offset the negative scale effect of trade. However, the technique effect of trade is less direct than the scale effect, and there are a number of crucial links that must be in place in order for the technique effect to operate fully. Among the most important are:

- effective market pressure;
- effective political pressure; and
- moderate discounting.

Effective Market Pressure

There must exist effective channels through which consumer demand can influence firms with respect to the environmental profile of their goods. A number of elements are important for that effectiveness. First, there must be *competition*. Consumer pressure is most effective when consumers have the choice of switching brands if they are dissatisfied with the environmental profile of their current brand choice. Without competition, the only choice open to "green consumers" who are concerned with the environmental profile of a particular product is to not buy that product at all; this requires a much more dedicated "greenness" on the part of consumers than simply switching brands.

An equally important element of effective consumer pressure is *information*. If consumers are to be able to influence the environmental profiles of the products they buy then they need to be well informed about those environmental profiles. (Similarly, "green investors" need to be well-informed about the environmental practices of the firms in

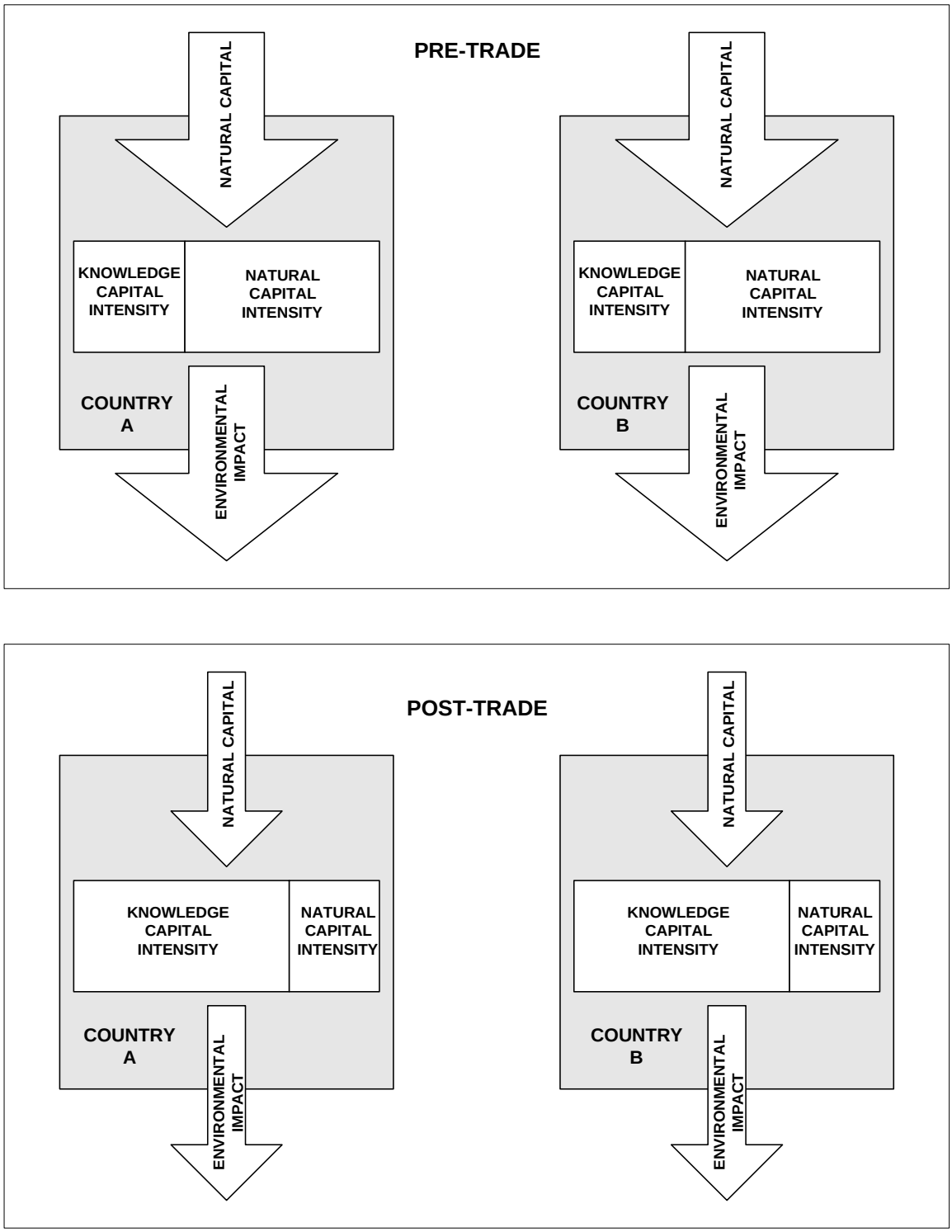

Figure 5.2

The Technique Effect of Trade

which they invest). There is an important role for policy intervention in this area.[1]

Competition and information are necessary elements of effective consumer pressure but they are not sufficient. The *externality* associated with the consumption of a polluting product (that is, the associated cost imposed on others for which the consumer does have to pay), means that the private benefit from cutting consumption or switching brands does not fully reflect the true social benefit, even for "green consumers". For this reason, it is not enough to rely on the market alone to bring sufficient pressure to bear on firms to improve their environmental practices; there remains a role for policy, beyond the fostering of competition and the provision of information.[2]

An additional impediment to the effectiveness of consumer pressure is the geographical separation of consumption and production associated with trade. If products produced with highly polluting methods are sold principally to consumers in a foreign country, then there is little scope for domestic consumers to influence production practices. While "green consumers" in the foreign country may have some concern for environmental quality in the country where the good is produced, that concern is likely to be less than if those consumers were affected directly. It is also subject to *a public good problem*. That is, each consumer will tend to "free-ride" on the efforts of other consumers to protect the environment in the producing country. Moreover, the information available to foreign consumers about environmental practices in the producing country is likely to be minimal.[3]

Effective Political Pressure

To the extent that policy intervention is needed to foster and augment the role of the market in translating "green consumerism" into cleaner production, there must exist effective channels through which consumers can bring pressure to bear on their politicians to implement those policies. In this respect, well developed *social capital* is

[1] This is discussed at greater length in chapter 10 (section 10.5).
[2] See chapter 10 for a discussion of the role for policy.

crucial to the realization of a production technique effect, and to the attainment of sustainable development in general. Policy-makers must be accountable to individuals, both through the voting booth and through a well-functioning, independent judiciary.

Moderate Discounting

There are likely to be long lags between the growth in wealth that spawns heightened concern for the environment, and the consumer pressure needed to induce the adoption of cleaner techniques. If those lags are long enough, then extensive and irreversible damage may be done to the environment before individuals become wealthy enough to be concerned about it. When they finally do become concerned, it may be too late to do anything about it. This possibility is all the more likely if individuals discount the future heavily, such that the environmental costs to be borne in the future receive much less weight than the desire for growth today. This issue lies at the heart of sustainable development; by definition, sustainable development is development that reflects the importance of the future. Open access to resources and public good problems can lead economies to impose discount rates that are higher than is socially optimal. There is an important role for policy to correct for those problems and thereby ensure that market discount rates are not artificially high.

5.4 The Composition Effect of Trade

The scale and technique effects operate in the same directions for all countries: the scale effect tends to impact negatively on the environment, while the technique effect tends to impact positively. In contrast, the composition effect impacts different countries in opposite ways. The composition effect relates directly to the changes in production patterns that accompany specialization according to comparative advantage and the exploitation of scale economies. Consider two countries, country A and country B. Suppose country A has a relative abundance of non-natural economic capital (knowledge

[3] In this respect, international environmental certification, such as the ISO 14000 code, can be valuable under some circumstances. See Chapters 8 (section 8.6) and 10 (section 10.5) for further discussion.

capital, manufactured capital and social capital) and the country B has a relative abundance of natural capital. Specialization according to comparative advantage will tend to induce a relative expansion of non-natural capital-intensive industries in country A and a relative expansion of natural capital-intensive industries in country B. That is, the *composition* of production will change in both countries, but in opposite directions.

The composition effect is illustrated in Figure 5.3. Both countries initially have similar production compositions, but after trade, country B becomes relatively more natural-capital intensive in its production, and country A becomes less so. Consequently, the material throughput in country B expands relative to country A, and the associated environmental impact is similarly shifted towards country B.

The composition effect induces a negative environmental impact for some countries and a positive one for others. In particular, countries with an abundance of natural capital relative to other forms of capital, especially knowledge capital, will tend to be affected negatively. In this respect, it is very important to note that specialization in *relatively* natural capital-intensive production does not necessarily mean a specialization in resource-based primary production. For example, industrialization in developing countries, combined with a shift towards knowledge-based industries in developed countries, is in fact a reflection of specialization by developing countries in *relatively* natural capital-intensive production. In particular, an abundance of relatively unskilled labor plus a wealth-related higher environmental damage tolerance in developing countries, together with a relative abundance of knowledge capital in developed countries, gives rise to a comparative advantage in labor-intensive and relatively polluting industries in developing countries.[4]

[4] To see this point from a different perspective, note that a "comparative advantage in relatively polluting industries" is exactly equivalent to "a comparative advantage in high environmental-impact-tolerance-intensive industry", and environmental impact tolerance (as related to assimilative capacity) is a key element of natural capital. Moreover, a relative abundance of environmental impact tolerance relates as much to the *valuation* of environmental impacts as it does to the physical magnitude of the environmental impact. In particular, a wealth-related lower valuation of environmental impact can give rise to an abundance of environmental impact tolerance in one country relative to another even if the two countries have identical physical characteristics. It is in this sense that developing countries have a comparative advantage in relatively polluting industries. See Chapter 1 (section 1.4) for more detail.

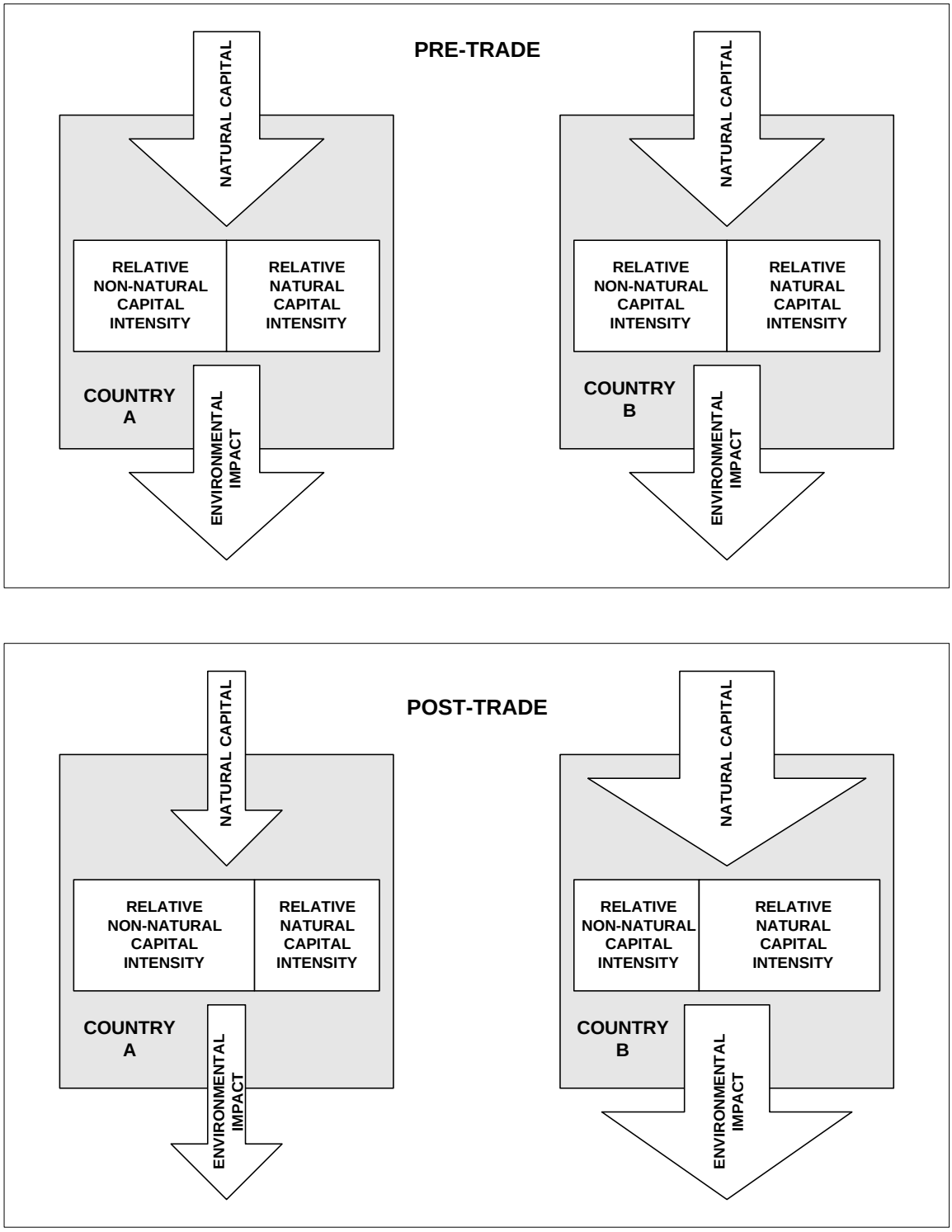

Figure 5.3

The Composition Effect of Trade

It is precisely this aspect of trade that underlies concerns that trade liberalization will induce a migration of relatively polluting industries to developing countries. However, it must be remembered that an increase in *relatively* polluting industries (that is, relative to those in developed countries) does not necessarily entail an increase in the absolute level of pollution. The technique effect of trade can mean that the absolute level of pollution actually declines even for countries that specialize in relatively polluting industries.

5.5 The Net Effect of Trade on the Environment: the Importance of Policy

The scale effect of trade on the environment is negative, the technique effect is positive, and the composition effect is positive for some countries and negative for others. What is the likely net effect of trade on the environment? The answer depends critically on the type of policies implemented. It was noted earlier that the key to fostering global sustainable development through trade is the substitution of knowledge capital for natural capital in production (the technique effect of trade); fostering that substitution calls for judicious policy intervention. With that intervention, trade can be a positive force for the environment, in both developed and developing countries.

There are three additional issues that must be taken into account in the design of policy to implement sustainable development through trade. First, the composition effect of trade necessarily means that some sectors expand while other sectors contract (at least in relative terms). Associated with these changes, and with sectoral contractions in particular, are significant adjustment and displacement costs. Managing these costs is a key requirement of sound policy. (These issues are the subject of Chapters 6 and 7).

Second, the strategic interaction between countries that accompanies trade, and its implications for the distortion of domestic environmental policies, can erode many of the potential benefits of trade liberalization. Solving that problem requires policy cooperation at the global level. (These issues are the subject of Chapter 8).

Third, trade liberalization alone, even if managed properly to realize its full potential net benefits, may not be sufficient to foster global sustainable development. The existence of significant global transboundary environment impacts of production and consumption (such as global climate change) may necessitate a redistribution of wealth around the globe in order to foster global sustainable development. (These issues are the subject of Chapter 9).

5.6 Synopsis

- Trade liberalization affects environmental quality through its impact on the volume and composition of resource flows within the economy.
- The three main channels through which that impact occurs are a scale effect, a technique effect and a composition effect.
- The scale effect reflects the increase in the volume of production and consumption associated with trade-induced specialization according to comparative advantage, and the exploitation of scale economies. The environmental impact is negative.
- The technique effect reflects the substitution of knowledge capital for natural capital in response to a trade-induced, wealth-related increase in the demand for environmental quality. The environmental impact is positive. The technique effect is critical to sustainable development. Its strength relies on effective market and political pressures.
- The composition effect reflects the change in relative natural capital intensity in production across countries in response to specialization. The environmental impact is negative for countries with a comparative advantage in natural capital-intensive production, and positive for countries with a comparative advantage in non-natural capital-intensive production.
- The net effect of trade on the environment can be positive for both developed and developing countries if appropriate policy intervention is undertaken.

5.7 Related Reading

Anderson, Kym (1992), "Effects on the Environment and Welfare of Liberalizing World Trade: the Cases of Coal and Food", in Kym Anderson and Richard Blackhurst, (eds.), *The Greening of World Trade Issues*, The University of Michigan Press, Ann Arbor.

Copeland, Brian R. and M. Scott Taylor (1994), "North-South Trade and the Environment", *Quarterly Journal of Economics*, August, 755-787.

Environment and Resource Management Project Philippines (1996), *GATT-WTO and the Philippine Environment: Policy Safeguards to Ensure an Environment-Friendly Competitiveness in World Trade*, Institute of Environmental Science and Management, University of the Philippines at Los Banos.

Phuong, Tran Thi Thanh (1997), "AFTA and Its Environmental Implications for Vietnam", *Journal of Environment & Development*, 6, 341-349.

6. Trade Liberalization and Structural Adjustment

6.1 Introduction

Trade liberalization can precipitate substantial shifts in production patterns within an economy: some sectors of the economy expand while other sectors contract. This in turn means that trade liberalization can impose significant costs on some groups within society even while others derive significant benefits. Managing this adjustment process is a critical component of policy for sustainable development through trade.

This chapter examines the key issues relating to structural adjustment. We begin with a review of the structural adjustment that occurs in response to trade liberalization, and then examine how that adjustment affects different groups within the economy. We conclude with a discussion of key policy guidelines for the management of the structural adjustment process.

6.2 Trade Liberalization and Structural Adjustment

Trade liberalization can lead to significant shifts in the pattern of production. The two principal forces at work are specialization according to comparative advantage, and the exploitation of economies of scale and scope. The combination of these two forces can cause complicated adjustments in the economy. These adjustments occur at two levels:

- inter-sectoral adjustment; and
- intra-sectoral.

Inter-Sectoral Adjustment

Inter-sectoral adjustment refers to adjustment across sectors according to factor intensities. This type of adjustment reflects specialization according to comparative advantage. In the wealthier developed countries, global trade liberalization has induced a shift towards knowledge intensive manufacturing and services. In the developing countries of Asia and Latin America, it has induced a shift towards relatively low-skill labor-intensive, export-oriented manufacturing. This manufacturing also tends to be relatively pollution-intensive.[1]

This adjustment reflects specialization according to comparative advantage. Developed countries have a relative abundance of knowledge capital, and a wealth-related higher valuation of environmental quality. In contrast, developing countries have a relative abundance of low-skill labor and a wealth-related lower valuation of environmental quality.[2]

One important consequence of trade-induced inter-sectoral adjustment in developing countries is rapid urbanization. Manufacturing is concentrated in urban areas and the relative expansion of this sector has caused an influx of people from rural areas. The environmental impacts of this urbanization are among the most serious problems for developing countries. These issues are discussed in detail in chapter 7.

Intra-Sectoral Adjustment

Intra-sectoral adjustment refers to adjustment across the industries and firms within a sector. This type of adjustment reflects the exploitation of economies of scale and scope. Intra-sectoral adjustment can mean that some industries and firms contract even though the sectors of which they are part expand on average, and that some firms and industries expand even though the sectors of which they are part contract on average. For example,

[1] Note that this does not imply that environmental quality will necessarily fall in the developing country after trade liberalization. A shift from natural capital to knowledge capital in both countries can potentially more than offset any negative effect. See Chapter 5 for a detailed discussion of this *technique effect* of trade.

[2] This is the composition effect of trade described in Chapter 5.

a developing country may not have a comparative advantage overall in knowledge-intensive production, but an individual knowledge-intensive firm based in that country may prosper after trade liberalization because it has been better able than its foreign rivals to exploit production scale economies, or because it has obtained a first-mover advantage in technology or distribution channels. [3] Conversely, the exploitation of economies of scale in agriculture in some developed countries yields a productivity advantage over some developing countries despite an overall comparative disadvantage in natural capital-intensive production.

6.3 Winners and Losers from Trade Liberalization

There are two main groups of beneficiaries from trade liberalization: consumers, and the stakeholders (workers, suppliers and shareholders) in industries that expand due to freer trade. Those who lose from trade liberalization are the stakeholders in industries that contract. When economists state that trade liberalization is "welfare-enhancing" for a country they typically mean that the gains to the winners more than offset the losses to the losers; that is, the winners could, in principle, compensate the losers and still be better off.[4] However, there is nothing inherent about trade liberalization to ensure that such compensation will actually occur. Trade liberalization can leave many groups decidedly worse off.

For some stakeholders, the costs of trade liberalization are likely to be short-lived. For example, well-diversified shareholders can gradually adjust their portfolios away from contracting industries towards expanding industries. Similarly, workers with general skills that are easily transferred from one industry to another will tend to find work in expanding industries after having been displaced from contracting industries. These

[3] Note that the *ex ante* difference between a "winning firm" and a "losing firm" can be very small indeed. A fortunate innovative breakthrough at the right time can eventually translate into industry dominance if economies of scale and scope are large enough. Witness the global dominance of Microsoft.
[4] Such a change is called a *potential Pareto improvement*, or equivalently, a surplus enhancing change.

groups will incur adjustment costs, but once the adjustment is made, they may well be better-off in the long run.

For other stakeholders, the costs of adjustment are likely to be much higher, and much longer lived. The worst affected group comprises workers whose skills are highly specific to industries that fall into relative decline. These workers will have to learn new skills before they can take advantage of the growth in expanding industries, and for many, especially older and less able workers, such learning can be very difficult. Many will be permanently displaced.

6.4 Policies for Managing Structural Adjustment

The asymmetric impact of trade liberalization on different groups within the economy, and the associated adjustment costs, raise a number of important issues. First and foremost, it raises the difficult question of exactly what constitutes societal welfare. Is "society" better off when some of its members gain and others lose, especially when the losers are the least well-off in the first place? This is essentially a political question. Individual attitudes, and the political structures through which those attitudes translate into societal norms, are the primary determinants of the degree to which inequality is acceptable in the society. However, economic theory has something to say about inequality at a pragmatic level; in particular, in relation to the tradeoff between equality and the creation of wealth.

The Trade-Off Between Equality and the Creation of Wealth

The creation of wealth requires the existence of *incentives*. For example, if every member of society was guaranteed an equal share of societal wealth, regardless of their contribution to its creation, then no individual would have a strong incentive to incur personal effort and risk to create that wealth. At a less extreme level, redistributive taxation erodes incentives to work and save. Thus, allowing some inequality in outcomes

(which is quite distinct from inequality of opportunity) is essential to the creation of wealth.

However, this negative relationship between equality of outcomes and wealth creation only extends so far. In particular, extreme inequality of wealth can undermine economic productivity for two important reasons. First, inequality can induce crime and other destructive, rent-seeking behavior. In the extreme, inequality can spawn large scale insurrection. Second, inequality can induce highly asymmetric political pressure, the result of which may be growth-deterring policy measures (depending on the distribution of political power). For example, in the case of trade liberalization, the costs are concentrated while the benefits are dispersed. The small group of stakeholders displaced because of structural adjustment have a much stronger incentive to incur the costs of political lobbying than does a large group of consumers, each of whom may only benefit by a small amount from freer trade. The resulting asymmetric political pressure could impede the trade liberalization process.

Thus, determining how much inequality to allow in a changing economy requires a delicate balancing of social justice, the creation of incentives and the prevention of damaging rent-seeking and political lobbying. In general, achieving that balance will require some policy intervention to manage structural adjustment in response to trade liberalization.

Principles for Managing Structural Adjustment

A number of key principles should be followed in managing structural adjustment. First and foremost, *structural adjustment should be managed rather than prevented*. It is generally inappropriate for government to intervene to "prop-up" a declining industry with subsidies and indirect protectionist measures. Uncompetitive industries must be allowed to contract. Moreover, some degree of domestic industrial concentration will likely have to be allowed so that domestic companies can take advantage of scale economies, and compete successfully in the global market place.

Second, adjustment costs are usually lower if structural adjustment occurs slowly. That is not to say that "slower is always better", but it does mean that trade liberalization should be phased in over time, with changes announced well in advance, and *announced timetables for change* adhered to strictly.

Third, *incentive-based mitigation* is likely to be far more productive than lump-sum compensation for affected individuals. For example, policies to assist displaced workers should be based on education and re-tooling, rather than on untied unemployment assistance.

Fourth, management measures should *foster economic flexibility*. In particular, it is almost always inappropriate for government to attempt to pick future "winners" and channel resources into those industries. Markets are typically much better at identifying productive ventures than governments. The comparative advantage of government lies in the provision of political stability, enforceable property rights, general infrastructure and high quality general education. These public factors provide markets with a solid base from which to respond flexibly to changing global conditions.

6.5 Synopsis

- Trade liberalization can lead to dramatic shifts in the pattern of production. The two principal forces at work are:
    - ◊ specialization according to comparative advantage; and
    - ◊ the exploitation of economies of scale and scope.
- Inter-sectoral adjustment refers to changes in the sectoral composition of production according to relative factor intensity. It reflects specialization according to comparative advantage.
- Intra-sectoral adjustment refers to expansions and contractions in industries within a sector. It reflects the exploitation of economies of scale and scope.

- The combination of inter-sectoral and intra-sectoral adjustment can lead to complex changes in the pattern of production. Some sectors will expand on average while others will contract on average (at least in relative terms), but within any given sector there may be expansion of some industries and contraction of others.
- Some stakeholders in the economy will gain from trade liberalization, while others will lose. Those most likely to lose are workers with skills that are specific to industries in relative decline, and for whom learning is difficult.
- The key policy principles for managing structural adjustment are:
    - ◊ structural adjustment should be managed rather than prevented: industries must be allowed to expand or contract according to market pressures;
    - ◊ trade liberalization policies should be phased in over time according to an announced timetable;
    - ◊ mitigation measures should be incentive-based; and
    - ◊ policy should foster economic flexibility through the provision of key public factors.

6.6 Related Reading

Edwards, Sebastian (1997), "Trade Policy, Growth, and Income Distribution", *American Economic Review*, 87, 205-210.

Levy, Santiago and Sweder van Wijnbergen (1995), "Transition Problems in Economic Reform: Agriculture in the North American Free Trade Agreement", *American Economic Review*, 85, 738-754.

Persson, Torsten and Guido Tabellini (1994), "Is Inequality Harmful for Growth?", *American Economic Review*, 84(30), 600-621.

7. Trade, Urbanization and the Environment

7.1 Introduction

Urbanization is one of the main consequences of the production shifts that accompany trade liberalization and technological change. The percentage of people living in cities around the world is higher now than at any time in history, and the trend is towards even further urbanization, especially in developing countries. For many people, cities offer a better life than can be had in rural areas, but for the urban poor, who are exposed to a broad range of environmental hazards and at the same time have little access to urban amenities, life is often much worse in cities than in the countryside.

In this chapter we review the main issues with respect to trade, urbanization and the environment. We begin with a brief overview of current trends towards urbanization around the globe, and then discuss the link between urbanization and trade liberalization in developing countries. We then review the main environmental impacts of urbanization. We conclude with a discussion of the role for policy with respect to urbanization.

7.2 Current Trends[1]

The fraction of the world's population living in urban areas in 1975 was roughly 34%. By the year 2000 that fraction will have increased to over 50%. By the year 2020 it will likely have increased to nearly two-thirds. Coupled with absolute population growth, this trend means that over 5 billion people will be living in urban areas by the year 2020.

[1] The data source for this section is World Resources Institute (1996), *World Resources: A Guide to the Global Environment 1996-97*, Oxford University Press, New York.

The most rapid change is happening in developing countries. Urban population growth rates in the developing world are around 3.5% annually; the corresponding figure for developed countries is about 1%. Growth rates are highest in Africa and Asia, at around 4%, building on a current urban population fraction of around 30%. Growth rates are lower in Latin America and the Caribbean, but these regions are already more than 70% urbanized.

While current urbanization growth rates in developing countries are not dissimilar to those that occurred in developed countries during the previous century, the absolute number of people now living in urban areas is without precedent.

7.3 Urbanization and Trade Liberalization

The framework for our discussion is illustrated in Figures 7.1 and 7.2. These figures depict *relative* values for the urban and rural economies for a number of key economic and demographic elements before and after trade liberalization. (We will say something about absolute values later).

The Rural Economy

Figure 7.1 illustrates the equilibrium between the rural and urban economies before trade liberalization. Consider first the rural economy. The primary determinant of individual welfare in the rural economy is the agricultural land base. Also of key importance is the level of public amenities and infrastructure, such as access to drinking water, sanitation, waste collection, health services, education, and communication and transportation links. The third key determinant of welfare is the level of environmental quality.

These determinants of welfare are of course inter-related. The productivity of the land base is a determinant of the wealth available for the provision of public amenities, and the level of public amenities is a key determinant of productivity. Moreover,

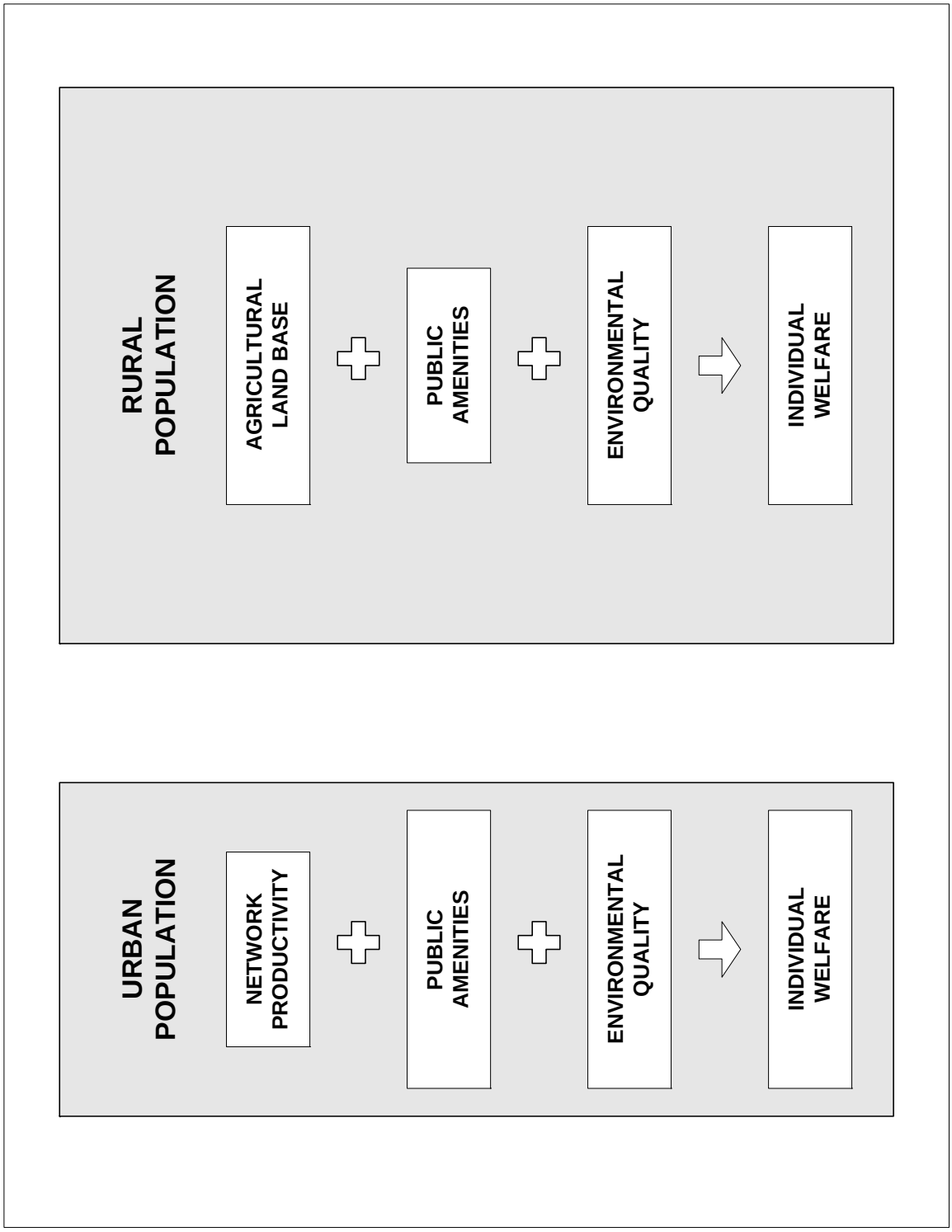

Figure 7.1

Equilibrium Before Trade Liberalization

environmental quality is a function of the level of public amenities (especially with respect to sanitation and waste collection), and at the same time is a key determinant of productivity. The productivity of the land base is in turn important to environmental quality because the valuation of environmental quality is an increasing function of wealth.

The Urban Economy

Next consider the urban economy. The engines of wealth in the urban economy are manufacturing and services. The productivity of these sectors is determined largely by *network effects.* The simplest example of a network effect relates to telephones: the usefulness of a telephone to any individual is increasing in the number of other people who have telephones. Similar network effects pervade the manufacturing and service sectors, with respect to business contacts, information exchange, financial services, supply and distribution links, etc. The importance of network effects is one of the main reasons that the manufacturing and service sectors typically locate in cities: the productivity of business networks relies to a large degree on people being within close proximity of each other. Developments in communications technology may eventually reduce the importance of physical proximity but for some time to come, especially in developing countries, physical proximity will continue to matter.[2]

The network effects that bring people together in cities also facilitate the exploitation of *economies of scale and scope* in the provision of public amenities and infrastructure. These public factors in turn enhance the productivity of industry and foster the creation of additional wealth. The creation of wealth allows the provision of additional infrastructure and amenities and draws more people to the cities. Thus, to a large extent, cities have been the engines of their own growth.

[2] The communications revolution in developed countries combined with their knowledge-intensive production may mean a declining importance of extremely large cities in the future. However, the magnitude of physical economies of scale and scope in cities (see below) nonetheless mean that small cities will continue to be important.

There are of course limits to the productive growth of cities. Three key factors limit the returns to city size. First, economies of scale and scope in the provision of infrastructure and amenities eventually become exhausted. Second, there are eventual diminishing returns to network size. Third, the environmental resources of the city region are finite and so become stressed under the impact of the increasing production and consumption activity. In terms of the materials balance framework reviewed in Chapter1, the material throughput from the city eventually exceeds the assimilative capacity of the natural system of which it is part, and the result is environmental degradation. This degradation manifests itself as air pollution, crowding, noise pollution, sanitation problems, solid waste problems, water pollution, etc. (These environmental impacts are discussed further in section 7.4 below).

Equilibrium

People migrate to cities from rural areas because they expect a higher standard of living in the city. That migration continues until the level of welfare for an individual of given private wealth is more-or-less equated in the two regions. Relocation costs will of course present an obstacle to migration for many people, so the equality of individual welfare is not exact. Moreover, misinformed beliefs about one region providing a better life than the other may lead some people to migrate and actually become worse off, but the cost of relocation prevents them from returning to their original location.[3]

Equilibrium is illustrated in Figure 7.1. Welfare for any given individual is the same in both regions. Thus, the individual has no incentive to relocate to one or the other. The productivity of the agricultural land base in the rural region is sufficiently high relative to the opportunities available in the urban industrial sectors that it just compensates for the relative lack of public amenities in the rural sector. (Environmental quality is illustrated as being the same in both regions but it could be higher or lower in the urban area).

[3] Well-informed beliefs combined with plain bad luck can yield the same outcome.

Many events can disrupt the relative population equilibrium between the rural and urban regions. For example, war, drought or pestilence in the rural area can precipitate migration to cities. A disease outbreak or economic recession in urban regions can cause the reverse movement of people. *Absolute* population growth in both regions can also precipitate a change in relative populations (especially since the agricultural land base is often strictly limited). The "disruptive" event on which we wish to focus here is trade liberalization.

The Effect of Trade Liberalization

Trade liberalization for many developing countries, especially in Asia and Latin America, has meant a shift in relative production patterns towards relatively low-skill labor-intensive, export-oriented manufacturing, reflective of comparative advantage. This shift favors the urban economy. In particular, the productivity (in value terms) of the urban industrial network has grown substantially as a result of trade liberalization. The human face of this change is enhanced employment opportunities in cities. All other things equal, this would lead to a higher level of welfare for urban dwellers. However, that imbalance between relative welfare levels for rural and urban dwellers cannot persist as an equilibrium. Consequently, there is a migration from rural to urban areas.

This trade-induced migration is illustrated in Figure 7.2. Migration continues until welfare levels in the two regions are again equated. Three things bring about this equalization: enhanced *per-capita* productivity in the rural region (associated with fewer people relying on the fixed agricultural land base); diminishing returns to labor in the urban industries (reflected as lower relative wages for manufacturing workers); and reduced relative environmental quality in the urban region due to the increased scale of economic activity. The ensuing equilibrium involves a more productive urban industrial network, more urban infrastructure and public amenities, but lower relative environmental quality than before trade liberalization.

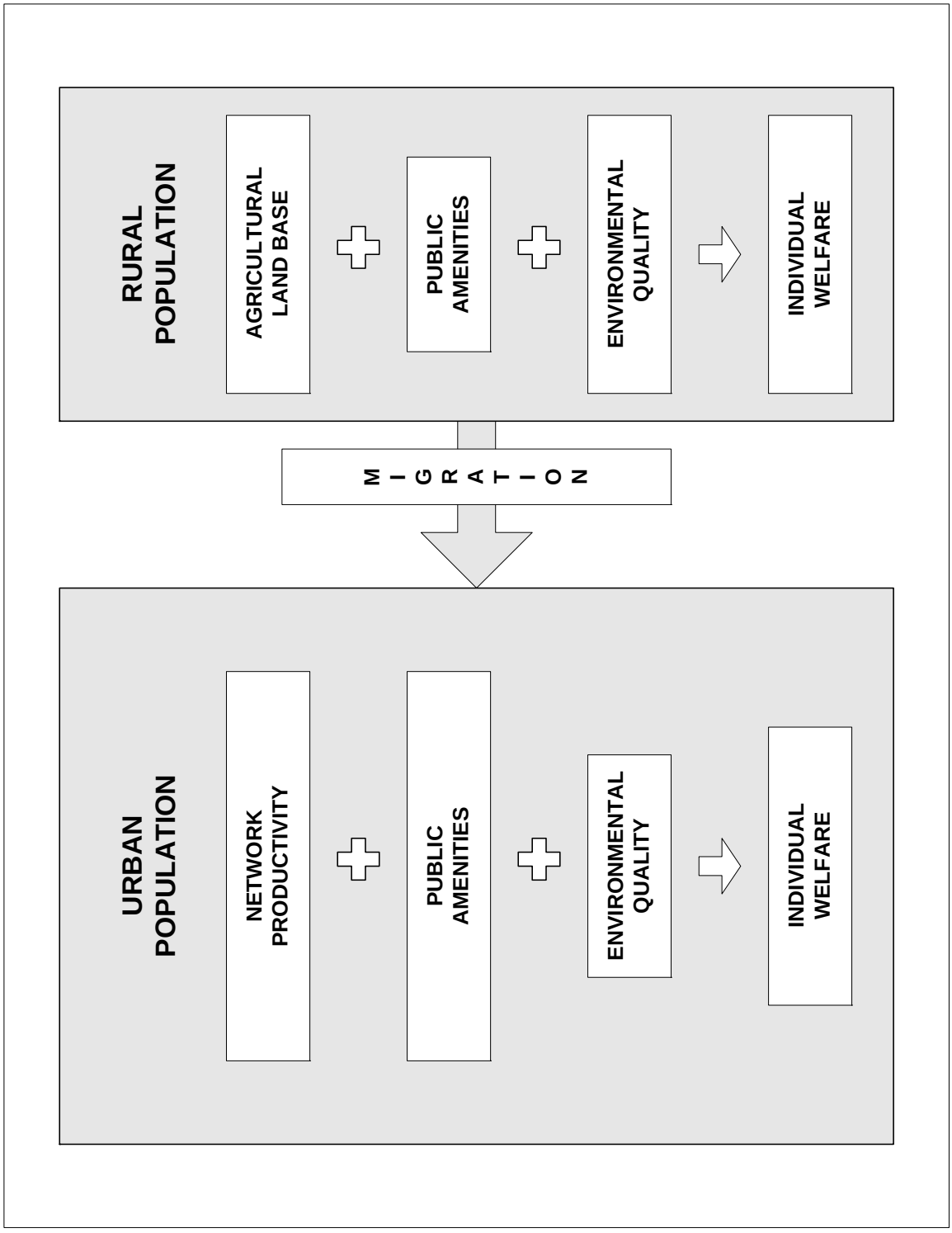

Figure 7.2

Equilibrium After Trade Liberalization and Migration

Relative vs. Absolute Environmental Quality

It is crucial to note that the *absolute* level of environmental quality in rural *and* urban areas could be higher after trade liberalization. In particular, the technique effect of trade liberalization (that is, the wealth-induced adoption of cleaner techniques) may lead to a higher level of environmental quality in urban areas despite the growth in population and the expansion of manufacturing. Of course, as noted in Chapter 5, the strength of the technique effect relies heavily on the design and implementation of appropriate policy. (See section 7.5 below for further discussion on policy).

7.4 The Environmental Impact of Urbanization[4]

The environmental impacts of urbanization stem both from the sheer numbers of people drawing upon very limited assimilative capacity, and from the types of economic activity that characterize urban areas. The main environmental problems are[5]:

- air pollution;
- solid and hazardous waste disposal;
- wastewater disposal; and
- water supply and sanitation problems.

Air Pollution

Urban ambient air pollution is a growing problem in developing countries. The main sources of urban air pollution are power generating plants, industrial activity, and transportation. The importance of transportation as a pollution source is likely to increase substantially in the near future as car ownership rates rise, especially in Asia and Latin America. Among the most damaging urban pollutants in developing countries are carbon monoxide, lead, suspended particulates, and tropospheric ozone (the production of which

[4] This section provides only an overview of the main issues. A separate course unit, "Sectoral Examples: Brown Issues", deals with these issues in more detail.
[5] These are listed in alphabetical order. The order of importance varies across countries, and across cities within countries.

is due largely to emissions of nitrous oxides and volatile organic compounds).[6] These pollutants cause serious human health effects, as well as damage to crops, vegetation, and manufactured structures and materials.

Indoor air pollution is also a major problem in many developing countries, especially where there is a heavy reliance on animal dung and fuelwood for domestic cooking and heating.

Solid and Hazardous Waste Disposal

Urban areas produce large volumes of solid waste, both from households and from industry. A significant fraction of this waste goes uncollected in cities of the developing world. This uncollected waste is disposed of through a variety of unofficial means, including land dumping, disposal in waterways, and street litter. Much of this waste eventually finds its way into drains and sewers, creating serious blockages.

Hazardous waste disposal is also a growing problem in the cities of developing countries, since this is where most industrial activity is concentrated. Effluent from chemical plants, pulp and paper mills, and material treatment (such as leather tanning) is laden with a variety of toxic substances and heavy metals. This effluent is often discharged directly into drains and waterways.

Solid and hazardous waste that is collected properly still presents a serious disposal problem. Transportation to landfills and incinerators outside urban area is costly, improper landfill construction can mean that toxic substances still leach into groundwater, and low temperature incineration can cause serious air pollution problems.

Water Supply and Sanitation

The lack of adequate potable water supply and sanitation poses one of the most serious threats to human health in developing countries. These problems are often amplified

[6] See Chapter 3 for further discussion on these pollutants.

significantly in the poorest parts of urban areas, where large numbers of people are often crowded together in unsanitary conditions, and demands on drinking water are heavily concentrated.

Wastewater Disposal

Even where sanitation infrastructure is in place, the disposal of wastewater poses a serious problem. In developing countries, most wastewater is discharged directly into rivers, lakes and coastal waters without treatment. Depending on the degree of natural flushing in those water bodies, and their proximity to human populations, this untreated disposal can pose serious human health risks, and exacerbates the problem of providing potable water. It can also seriously disrupt marine ecosystems, leading to the contamination and depletion of food fish stocks, and increases in the incidence of vector borne diseases.

7.5 Urbanization and the Environment: the Role for Policy

Urbanization and its associated environmental problems present a huge challenge to policy intervention; there are a myriad of forces and market failures at play. In this section our objective is to characterize the "big picture" with respect to policy intervention rather than to focus on specific policy tools to address specific urban environmental problems.[7]

The basic principle of all policy is to implement a resource allocation target as a corrected equilibrium through the application of policy instruments to change private incentives. The resource allocation target is specified in terms of social costs and benefits with respect to some welfare criterion; sustainable development is one such a criterion. The key to good policy design is to first identify the important private choices that determine equilibrium outcomes, since this determines where policy instruments need to

[7] See Chapter 10 for a discussion of policy instruments, and the separate course unit, "Sectoral Examples: Brown Issues", for specific applications to urban environmental problems.

be targeted.[8] Figure 7.3 illustrates the key private choices with respect to urbanization and the environment.

We can think about these choices at three levels. First, there are the *production and consumption choices* by the individuals (and firms) within each region. These are the choices that most directly affect environmental quality, including choices with respect to sanitation, transportation mode, waste disposal, and in the case of firms, production technologies, etc. At a second level are *fertility choices*. These choices determine the absolute number of people in the two regions, and consequently, determine the scale of the environment impacts from any given set of choices with respect to production and consumption activities. At the third level are the *migration choices* discussed earlier. The quality of the urban and rural environments are a joint function of these three sets of choices.

These choices are of course inter-related (indicated by the connecting arrows in Figure 7.3). In particular, fertility and migration choices determine to a large degree the constraints that in turn influence choices with respect to production and consumption. Similarly, the production and consumption opportunities available affect migration and fertility choices.[9]

A role for policy arises where the equilibrium outcome from private choices does not correspond to the resource allocation target. This non-correspondence reflects a divergence of private costs and benefits from social costs and benefits. The presence of *externalities* is an important cause of that divergence. An externality is a cost or benefit associated with an activity that is external to (that is, not felt by) the individual

[8] It is important to be clear what is meant by a "choice" in the economic sense. A choice in the economic sense is an action based on preferences subject to the *constraints* faced by the individual. For the urban poor in developing countries, the constraints may be so limiting as to allow only one action with respect to some activities. For example, many people have no other option than to dispose of their waste in rivers. The action is nonetheless a "choice" in the economic sense.

[9] It is in this sense that population growth and migration patterns are both causes and effects of poverty. To attempt to tie down the causation in one direction or the other is to misleadingly over-simplify the issue.

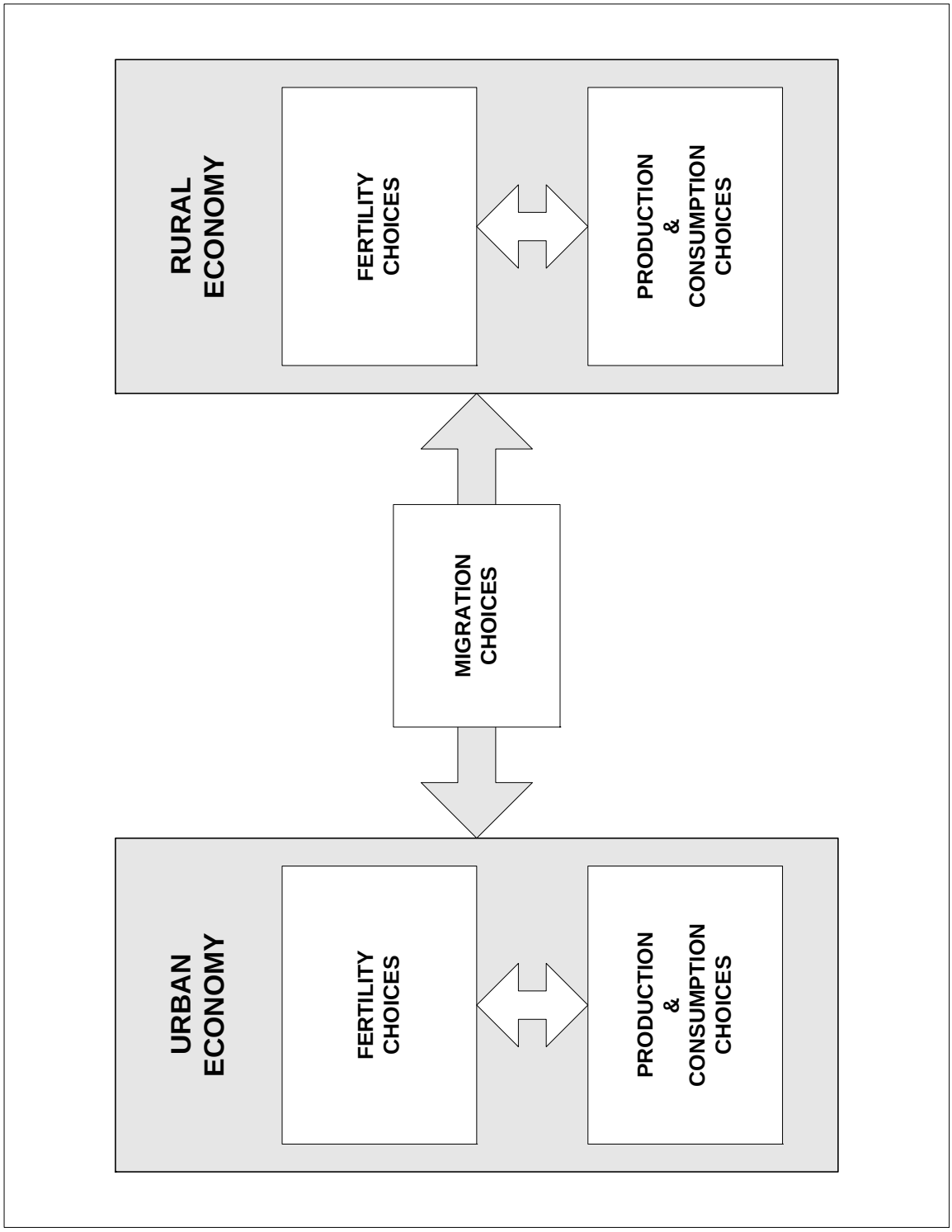

Figure 7.3

Urbanization and Private Choices

undertaking the activity. Externalities arise at all three choice levels illustrated in Figure 7.3.

Externalities Associated With Production and Consumption Activities

If an individual (or firm) does not have to pay a price (either explicit or implicit) for the pollution they cause, then they have no incentive to take into account the impact of that pollution on others when making production and consumption choices.

Externalities Associated With Fertility

Externalities are also present at the level of fertility choices. In particular, the private cost of fertility is generally less than the social cost. Much of that divergence stems directly from the unpriced externalities associated with the production and consumption choices that children will make when they become adults. That is, the environmental impact of one additional person on the globe is not taken into account by the parent of that person when deciding to have a child. This externality would vanish if the environmental impacts of production and consumption were correctly priced. However, there exist a number of other external fertility costs due to the existence of child-related subsidies, and publicly funded child health and education programs. On the other hand, fertility has at least one important positive externality: the provision of young workers to provide productive trading opportunities for those too old to produce for themselves.[10]

These fertility issues relate to the general question of population growth and are not specific to urbanization problems. However, any attempt to address the environmental problems associated with urbanization must recognize the importance of population growth. Approximately one half of the current growth in urban populations in developing countries is attributable to endogenous population growth; that is, fertility among urban

[10] This is distinct from the *private* benefit of producing an heir.

dwellers.[11] The remainder is due to migration from rural areas, but that migration is also at least partly motivated by population pressures on the agricultural land base.[12]

Externalities Associated With Migration

The third point at which externalities arise is at the level of migration decisions. There are two important externalities here. First, when choosing whether or not to migrate to an urban area, the individual does not take account of the environmental impacts her production and consumption activities will have when she arrives there. At the same time, she does not take account of the reduced environmental impact on the rural area when she leaves that area. The net externality could be positive or negative, but since environmental damage is typically convex (meaning that each additional impact causes more incremental damage than the last), the net effect will become increasingly negative as urban populations grow, and is likely already negative for many large cities.

The second externality associated with migration to urban areas relates to economies of scale in the provision of public infrastructure and amenities. Over the population range for which economies of scale exist, (and this range differs according to the congestability of the particular amenity concerned), the addition of one more person reduces the average cost of provision to the entire population.[13] The individual does not take into account this external benefit to other city dwellers when deciding whether or not to move to the city. On the other hand, there is a comparable external cost imposed on rural dwellers when an individual relocates to the city. The net effect could be positive or negative. However, for relocation to a large city whose infrastructure is already congested, the net effect is likely to be negative.

---

[11] Source: World Resources Institute (1996), *World Resources: A Guide to the Global Environment 1996-97*, Oxford University Press, New York.

[12] Recall that migration decisions are based on the *relative* appeal of urban and rural life.

[13] It is important to think in terms of the provision of infrastructure and amenity *services*, rather than the provision of physical structures. For example, the congestion of a road does not diminish the road itself, but it does diminish the transportation service that the road provides.

Some Key Principles for Policy Design

The plethora of externalities associated with urbanization might appear to render the task of policy overwhelming. There is no doubt that the policy problem is a challenging one, but the application of some key principles can help to simplify the problem.

First and foremost, policy should attempt to *target the source of the problem*, wherever possible.[14] We have seen that many of the externalities associated with fertility and migration choices in fact derive from lower level externalities associated with production and consumption choices. Addressing urbanization problems at this lower level is the best place to begin.

Second, under most circumstances, the best way to address an eternality problem is to *internalize it.* This means applying policy instruments to ensure that the external costs associated with production and consumption activities are taken into account in private choices. This involves putting a price, either explicitly or implicitly, on the external cost that an activity causes. In the case of pollution, this can be achieved through a variety of policy instruments, including taxes and fees, emission permits, and standards enforced by the threat of penalty. The best choice will depend on the particular circumstances. (See chapter 10 for further discussion on policy instruments). In the case of urban congestion problems, pricing can be implemented through policy instruments such as electronic road tolls, parking fees, unit water and wastewater fees, infrastructure fees on new developments, and tradeable land zoning permits.

7.6 Synopsis

- The global population is rapidly becoming much more urbanized. The fastest urbanization growth rates are in developing countries.

[14] Targeting the primary source of environmental damage can sometimes be difficult, due to monitoring problems. See Chapter 10 (section 10.6).

- Relative urban and rural populations are determined by an equilibrium in private location choices on the basis of relative welfare.
- The key determinants of welfare in both the rural and urban economies are: productive activity; the level of public infrastructure and amenities; and environmental quality. These elements are closely inter-related.
- The source of productive activity in the rural sector is the agricultural land base.
- The engines of growth in the urban economy are manufacturing and services. The productivity of these sectors is determined largely by network effects, which is why they typically locate in cities.
- The concentration of people in an urban area facilitates the exploitation of economies of scale and scope in the provision of public amenities and infrastructure.
- The equilibrium relative population of an urban area is limited by the eventual exhaustion of economies of scale, diminishing returns to network size; and the concentration of environmental impacts.
- Trade liberalization has caused a shift in production patterns in developing countries towards relatively low-skill labor-intensive, export oriented manufacturing. This has raised relative productivity in the urban areas and consequently, precipitated migration to those areas.
- The main environmental impacts of urbanization are: air pollution; solid and hazardous waste disposal; wastewater disposal; and water supply; and sanitation problems.
- The role for policy with respect to urbanization is to correct for the externalities associated with production and consumption activities, fertility choices, and migration choices.
- The place to begin is with the correct pricing of the environmental impacts of production and consumption activities.

7.7 Related Reading

Roberts, Bryan R. (1994), "Urbanization and the Environment in Developing Countries: Latin America in Comparative Perspective", Chapter 10 in Lourdes Arizpe, M. Priscilla Stone and David C. Major (eds.), *Population & Environment: Rethinking the Debate*, Westview Press, Boulder.

World Resources Institute (1996), Chapters 1-6 in *World Resources: A Guide to the Global Environment, 1996-97*, Oxford University Press, New York.

8. Trade, Competitiveness and the Environment

8.1 Introduction

The link between trade and the environment is bi-directional: the production and consumption patterns associated with trade have substantial environment impacts; and the policies designed to manage environmental impacts have important implications for competitiveness and the pattern of trade. This chapter focuses on the second of those links.

Opponents of freer trade often cite the potential for a “race to the bottom” in setting environmental regulation as a major problem with trade liberalization. The concern is that trading countries will attempt to gain a competitive edge over each other by relaxing environmental standards. If all countries engage in this practice then the outcome may be one in which all countries set lax environmental standards, incurring the associated environmental costs, but with no country actually benefiting from the competition.

While the potential exists for this “race to the bottom” outcome under some circumstances, it is not a necessary consequence of trade, and the problem can in principle be resolved through international coordination. Moreover, the quest for a competitive advantage can also work in the opposite direction. In particular, competitive pressure can in some circumstances lead to an inflation of environmental standards as a disguised protectionist measure, or as a strategy to gain a “technological leader” advantage. The key point is that environmental regulations do affect competitiveness, and so there exists the potential for the strategic distortion of environmental policy for trade-related goals.

This chapter addresses the main issues relating to trade, competitiveness and the environment. We begin with a discussion of imperfect global competition and its relationship to the existence of economic rents. We then relate that imperfect competition to the link between environmental policy and international competitiveness. We then focus on four particular aspects of that relationship: the productivity cost of poor environmental quality; the promotion of "technological leadership" through strict environmental standards; "environmental protectionism"; and the potential for a global "race to the bottom" in the setting of environmental standards. We conclude with a discussion of the need for international cooperation, and the integration of environmental accords into trade liberalization agreements.

8. 2 Imperfect Competition and Global Trade

Gains from trade liberalization stem primarily from specialization in production according to comparative advantage, and through the exploitation of economies of scale and scope. At the same time, economies of scale and scope can act as barriers to entry, and so lead to concentration (that is, a small number of large firms) in the associated industries. The rash of mergers between major international corporations over the past decade, especially in the pharmaceutical, telecommunications, financial services and aerospace industries, is a reflection of the concentration associated with globalization. That concentration has both positive and negative elements. On the positive side, the exploitation of economies of scale and scope through concentration can lead to substantial reductions in production costs. On the negative side, industry concentration can lead to "imperfect competition", where prices can be set well above average production cost due to the absence of competitive pressure. This means that the firms involved make above normal economic returns, or *economic rent*. That rent will be captured partly by shareholders, partly by labor (in the form of high-paying jobs) and partly by government (through taxation).

Whether or not concentration necessarily leads to imperfect competition and economic rents depends to a large extent on the characteristics of the particular industry involved. Industries with just two or three major firms can potentially be fiercely competitive while industries with five or six firms could actually be less so. On the other hand, tacit collusion between a very small number of firms can effectively eliminate all meaningful competition. A myriad of factors determine which outcome is more likely and we do not have the space to cover the issue fully here. The key point is that globalization-induced concentration has the potential to produce imperfect competition and associated economic rent.

8.3 Environmental Policy and Competitiveness

The framework for our discussion is illustrated in Figure 8.1. It illustrates the basic relationship between environmental policy, competitiveness and welfare. Tight environmental standards will tend to drive up the costs of production (at least in the short run).[1] This in turn erodes the international competitiveness of domestic firms. Consequently, the global market share held by domestic producers falls, and the share of global economic rent captured by the country falls with it.

The impact on environmental quality operates through two channels. First, for a given level of domestic production, tighter environmental standards mean an improvement in environmental quality. Second, the loss of global market share means that the level of production falls. This too leads to an improvement in environmental quality. However, the net impact on welfare is ambiguous: the improved environmental quality has a positive effect on welfare, but the loss of global economic rent reduces non-environmental wealth, and so affects welfare negatively. Finding a balance between these positive and negative effects on domestic welfare is the key to setting environmental standards for any individual country acting unilaterally.

[1] See section 8.6 for a discussion of possible long-term implications for costs through the impact on technology.

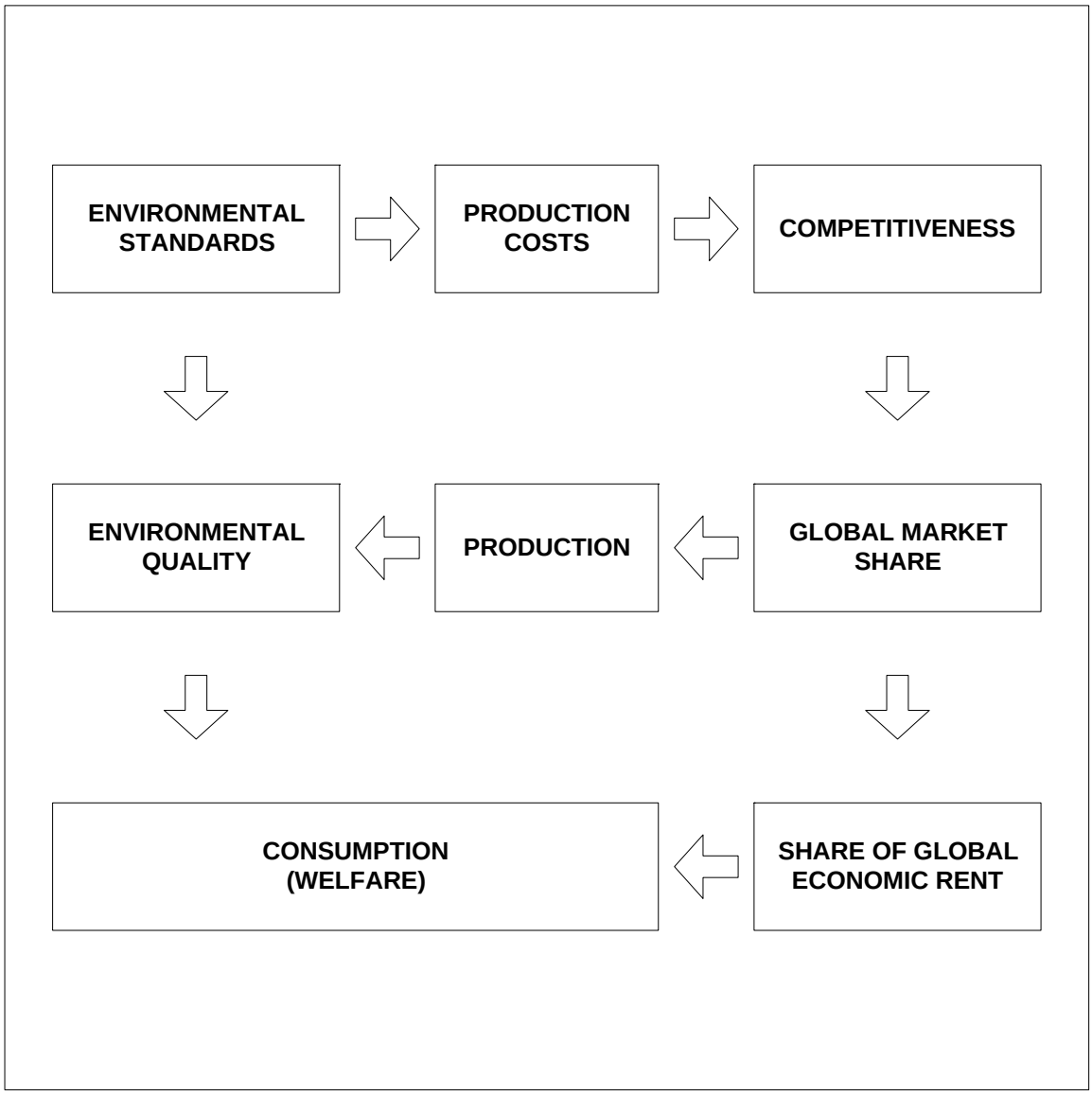

Figure 8.1

Environmental Policy and Competitiveness

Competitiveness and the Share of Global Economic Rent

An erosion of international competitiveness leads to a loss of global economic rent through a number of channels. First, existing domestic producers lose market share and cut production (at least in relative terms). Second, those same firms have an incentive to relocate in jurisdictions that have lower costs. In reality, this second channel appears to not be very important; the fixed adjustment costs of physical relocation are sufficiently high in many industries that the differential between countries in environmental standards would have to be extremely large to make relocation worthwhile for a firm. The third, and much more important, channel of impact is through new investment. International investment tends to flow where production costs are lower, all other things equal. Thus, tight environmental standards at home are likely to discourage foreign investment inflow, and enhance the attractiveness for domestic firms of investing abroad.

Some Important Qualifications

The negative relationship between environmental standards and international competitiveness is likely to hold on average over intermediate ranges of environmental quality. However, that negative relationship will not hold everywhere. There are three important factors that could imply a weaker negative relationship, and possibly even a positive relationship (under limited circumstances):

- the productivity costs of poor environmental quality;
- the promotion of technological change; and
- environmental protectionism.

These are discussed in sections 8.4, 8.5 and 8.6 respectively.

8.4 The Productivity Costs of Poor Environmental Quality

Even though lax environmental standards tend to reduce costs directly for individual firms, poor environmental quality overall can cause offsetting cost increases through reduced productivity. There are a number of important channels through which that can occur:

- human health effects and higher effective labor costs;
- damage to other productive elements of natural capital; and
- environmental conflict and political instability.

Human Health Effects and Higher Effective Labor Costs

Poor environmental quality can be a significant impediment to attracting highly skilled labor since wealthier individuals tend to put more weight on environmental quality. In addition, effective labor costs are higher if productivity is lower, and productivity is likely to be adversely affected by environmentally-induced health problems among workers.

Damage to Other Productive Elements of Natural Capital

Other factors of production may be affected negatively by poor environmental quality. For example, air pollution retards crop growth and damages materials; urban congestion imposes high time costs; water pollution can necessitate costly water filtration in some production processes; the siltation of waterways can degrade their navigability; and at a more global level, climate change can potentially disrupt production patterns on a massive scale.[2]

Environmental Conflict and Political Instability

Environmental damage can potentially lead to conflict, both within countries and between countries. In its mildest form, that conflict can cause significant legal and negotiation costs. At its worst, environmental conflict can lead to political instability and war.

[2] In the case of climate change, as with many environmental impacts, the rate of change is as important as the magnitude of change, since gradual adaptation to changing conditions can markedly reduce the costs of that change.

8.5 The Promotion of Technological Change

A great deal of debate has surrounded a recent hypothesis by Michael Porter of Harvard Business School that strict environmental standards can actually enhance competitiveness through the promotion of "technological leadership".[3] The basic idea is that strict environmental standards encourage firms to undertake research and development that they would not otherwise have done, which in turn leads to the innovation of new production technologies that have both cleaner environmental profiles, and lower direct costs. Securing patent protection over these innovations then allows the innovating firms to gain a competitive edge over their competitors in countries with weaker environmental standards.

As compelling as this optimistic hypothesis may sound, it does not hold up well to scrutiny. The anecdotal evidence offered in support of the hypothesis is subject to a severe selectivity bias problem, and the theoretical foundations are equally weak.[4] Nonetheless, the link between competitiveness, innovation and the environment is a crucial one, and debate over the so-called "Porter hypothesis" has helped to raise awareness of this point.

The attainment of long-run sustainable development rests wholly on the potential to substitute knowledge for natural capital in production. Technological innovation is the essence of that substitution. Moreover, the incentives created by unregulated market forces alone are unlikely to be sufficient to induce the right level or composition of innovative effort, since the environmental benefits of innovation are unpriced in an unregulated market. The key to fostering appropriate innovative effort to reduce reliance on natural capital is to correctly price environmental damage, and to that extent, setting tight environmental standards (implemented through pricing) is consistent with fostering future productivity. Indeed, this is one of the primary advantages of using economic instruments for pollution control (see Chapter 10).

[3] See Porter and van der Linde (1995).
[4] See Palmer, Oates and Portney (1995).

However, there is no justification for setting *excessively* strict environmental standards for the express purpose of fostering research and development towards achieving technological leadership. If the level of research and development in the economy is believed to be inadequate (due to capital market imperfections and problems of appropriation) then it is better to use policies that address that problem directly, rather than rely on the indirect influence of excessively strict environmental standards. As a general policy rule, policies should target problems directly at their source whenever possible.

8.6 Environmental Protectionism

Strict environmental standards imposed on production in the domestic economy will typically erode international competitiveness. However, the imposition of strict environmental standards for imported goods can do just the opposite; they can give a competitive advantage to domestic producers who compete with those imports. This does not mean that requiring high environmental standards for imported goods necessarily constitutes a disguised form of protection. Such requirements may be perfectly justified on strictly environmental grounds. In particular, the consumption of imported goods may have an environmental impact in the importing country that relates directly to the characteristics of that good. For example, imported toys painted with leaded paint impose a risk to children and are therefore prohibited in many countries.

A somewhat less direct, but equally justifiable case for restricting imported goods on environmental grounds relates to the generation of transboundary pollution in the production of those goods. Even though production takes place outside the importing country, the environmental consequences of that production may be felt by the citizens of that country. However, recognition of this point leads to a gray area. In particular, is it justifiable for the importing country to impose restrictions on goods whose production causes no physical damage to its citizens but nonetheless imposes *psychic costs*? Under

current World Trade Organization (WTO) rules it is judged not to be.[5] However, from an economic perspective, the distinction between physical damage and psychic damage is an artificial one, and it is difficult to make a solid argument against cases involving psychic costs based on environmental grounds alone. The problem with allowing import restrictions based on environmentally-induced physic costs is one of objective measurement: how are cases based on genuine psychic cost to be distinguished from wholly insincere protectionist-motivated claims? This is an issue with which the WTO will no doubt have to grapple with eventually.[6]

Other forces are also at work in global markets that blur the line between environmental management and environmental protectionism. Perhaps most important among them are *product certification* and *eco-labeling*. The International Standards Office (ISO) 14000 certification code now includes specific environmental criteria for some products. For example, ISO 14000-certified timber is now subject to a "sustainable forest management" criterion. Eco-labeling is a less formal form of certification wherein a product carries a label identifying it as "environmentally friendly" in some particular sense. These information-based schemes, designed to mobilize "green consumerism", have the potential to be powerful and valuable policy instruments. However, they also have the potential to be used as protectionist measures, particularly against developing countries. The crux of the issue is not whether the information schemes themselves are valuable, but whether the standards for certification or qualification for eco-labeling should be uniform across the world. Clearly the answer is "no". It is an elementary textbook result in environmental economics that uniform standards are generally inefficient. This is true whether the application is to different firms within a given industry in a given country, or

[5] Consider the ruling by the WTO (then GATT) with respect to the case of Mexico versus the United States over restrictions on the importation to the United States of canned tuna, caught in a manner that the United States argued to be harmful to dolphins, and therefore also harmful to the citizens of the United States who care about the welfare of dolphins. The WTO ruled against the United States.

[6] Perhaps the best test of sincerity is willingness-to-pay. This of course raises the all-important issue of the global distribution of property rights: should citizens of one country have to pay to stop the killing of dolphins in international waters by another country, or to reduce emissions of carbon dioxide from another country, or do they instead have a right not to be harmed by these things? Issues of this nature are discussed in Chapter 9.

to different countries, whose wealth, technology and environmental conditions differ dramatically.

8.7 The Potential for a "Race to the Bottom"

In section 8.3 we noted that the key to setting environmental standards for any individual country *acting unilaterally* is to find the right balance between the costs of environmental damage and the benefits of capturing a share of global economic rent. The problem from a global perspective is that all countries acting unilaterally in their own self-interest can potentially precipitate a destructive "race to the bottom" in setting environmental standards.

The problem is illustrated for the simple case of two countries in Figures 8.2 to 8.4. Figure 8.2 depicts a situation where both countries set environmental standards without strategic distortion for trade-related purposes. In comparison, Figure 8.3 illustrates the effect of a unilateral relaxation of environmental standards by country *A.* The effect for country *A* is a lower level of environmental quality but a higher share of global economic rent, with a net positive effect on domestic welfare. It is therefore in the best self-interest of country *A* to undertake the relaxation. In contrast, the loss of global market share for country *B* translates into higher environmental quality in that country but a significant loss of global economic rent. The net welfare effect for country *B* is negative. It is therefore in the best self-interest of country *B* to respond by relaxing its own environmental standards. The equilibrium outcome is illustrated in Figure 8.4. Neither country gains a competitive advantage over the other - each having matched the other's relaxation of standards - and the outcome is simply one with lower environmental quality

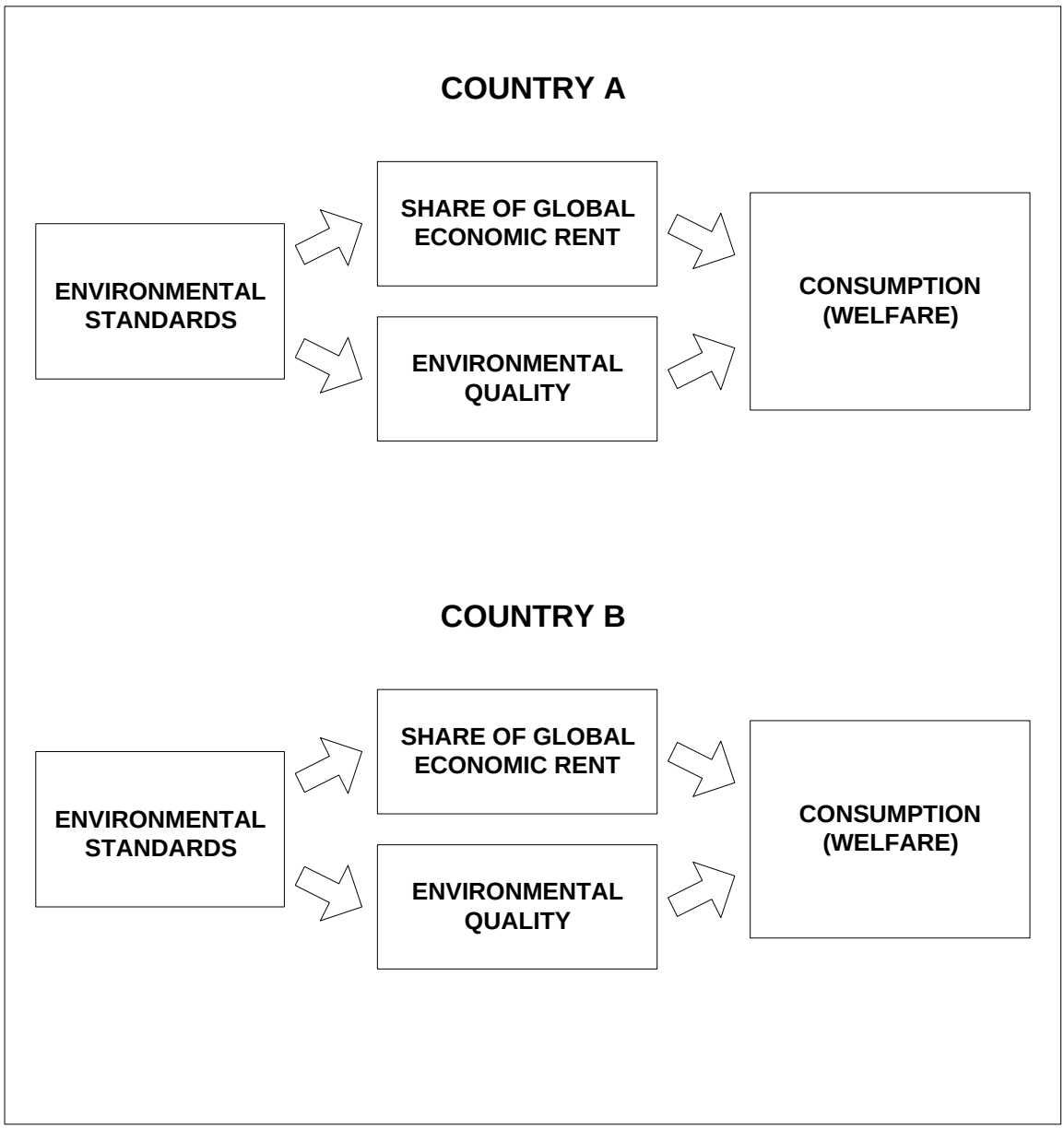

Figure 8.2

Environmental Standards Without Strategic Distortion

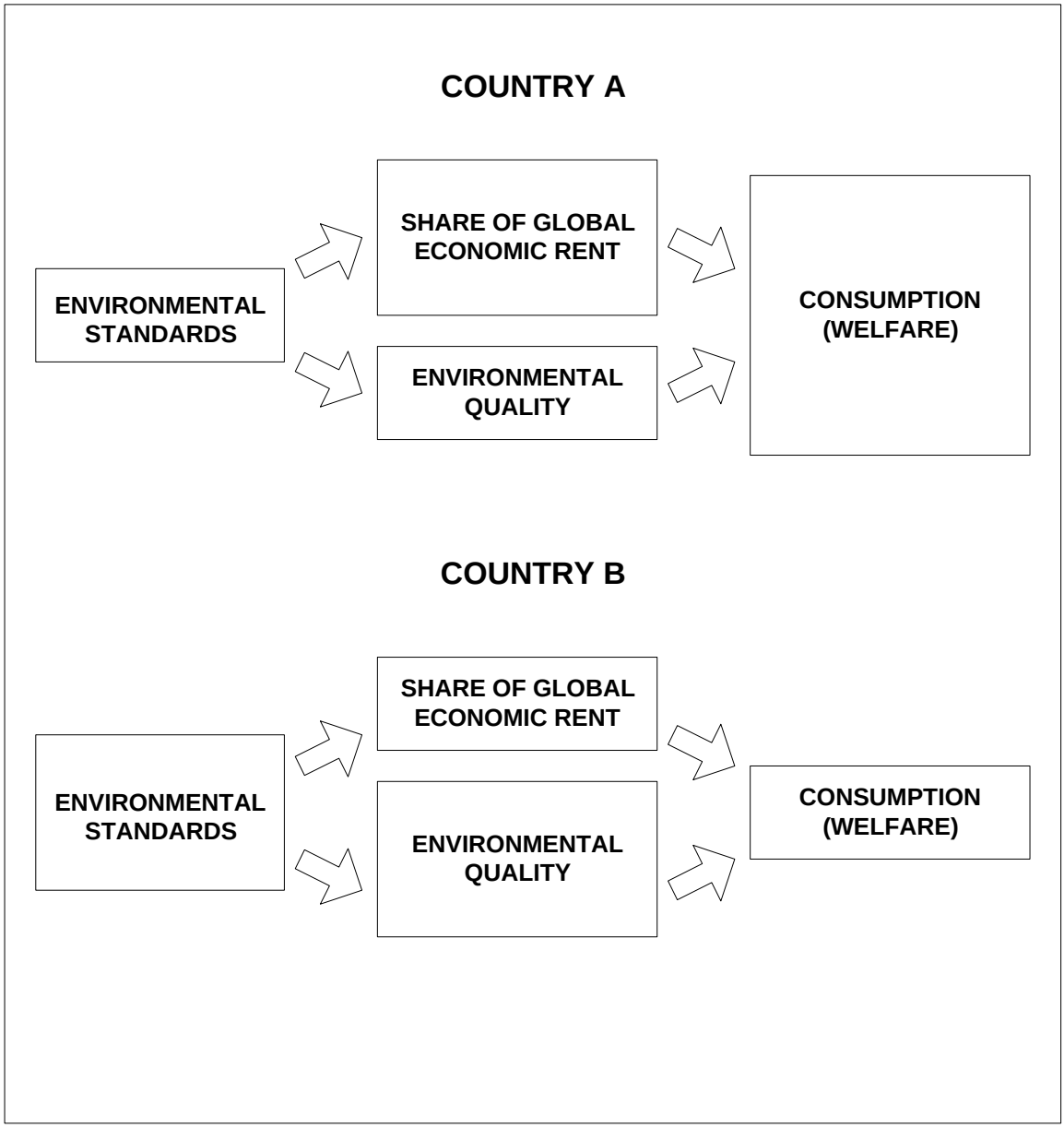

Figure 8.3

Unilateral Relaxation of Environmental Standards by Country A

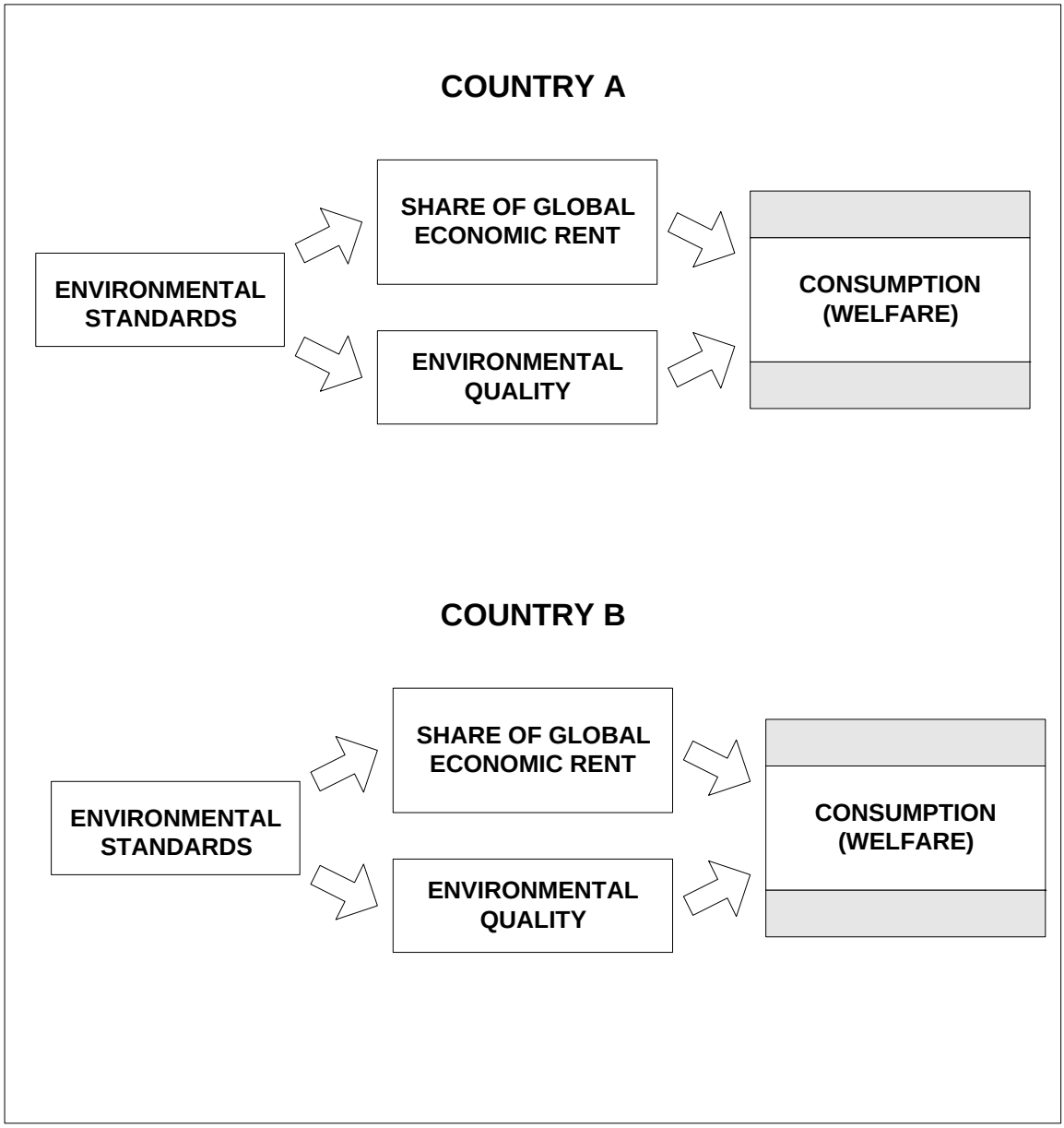

Figure 8.4

Equilibrium Strategic Distortion of Environmental Standards

and lower welfare for both countries. (The shaded areas in Figure 8.4 represent the welfare loss relative to the no-distortion benchmark). Thus, the strategic distortion of environmental standards is mutually destructive, but both countries nonetheless have a strict incentive to engage in the unilateral relaxation of those standards.[7] This underscores the need for comprehensive cooperative multilateral agreements.

8.8 The Importance of Integration and International Cooperation

The equilibrium outcome of strategic distortion in environmental standard setting is unlikely to involve an abandonment of standards altogether, since the costs of extreme environmental damage outweigh (and erode) the benefits associated with capturing global rents. Nonetheless, the distortion of environmental standards (and other areas of social and economic policy) has the potential to seriously undermine the benefits of trade liberalization. This does not mean that trade liberalization should be blocked. Rather, it means that mutually beneficial multilateralism must involve more than trade liberalization alone.

It is essential that trade liberalization agreements include comprehensive side agreements on environmental protection. This does *not* mean that environmental standards should be made uniform across countries; it means that environmental policy should be coordinated across countries in such a way as to prevent its strategic distortion for trade-related purposes. This is of course much more easily said than done. The implementation problem is especially challenging with respect to trade between developed and developing countries The potentially wide, but appropriate, differences in environmental standards between those country groups makes it very difficult to discriminate between strategic distortion and justified asymmetry on relative wealth grounds.

[7] The problem is a variation on the famous “prisoners dilemma” in which each of two captured criminals has an incentive to cheat on a collusive pact not to confess, even though both are made worse-off by the cheating.

The potential for the strategic distortion of environmental standards under free trade is just one aspect of a wider problem. In particular, trade liberalization does not eliminate the incentive for individual countries to attempt to capture a larger share of global rents; trade liberalization simply restricts the set of policy instruments available for that purpose. As the use of tariffs and quotas is restricted, non-trade policy instruments - such as environmental standards, health and safety standards, and tax policies - are distorted to take on trade-related objectives. There is no guarantee at all that the benefits of freer trade offset the costs of this distortion. All countries can potentially benefit from the multilateral coordination of policy, including the adoption of trade liberalization agreements, but if that coordination is not sufficiently wide-ranging, then those benefits are unlikely to be fully realized. Too little globalization can be worse than no globalization at all.

The need for comprehensive cooperation between countries is especially great when trade-induced strategic interaction between those countries is further complicated by the presence of transboundary pollution and the highly skewed distribution of global wealth. These issues are addressed in Chapter 9.

8.9 Synopsis

- The link between trade and the environment is bi-directional: the production and consumption patterns associated with trade have substantial environmental impacts; and the policies designed to manage environmental impacts have important implications for competitiveness and the pattern of trade.
- Economies of scale and scope can lead to imperfect global competition and the associated existence of economic rent.
- National governments have an incentive to distort environmental policy in an attempt to capture a greater share of global economic rent for its citizens; this can lead to downward pressure on environmental standards.

- There are some important qualifications to this negative relationship between competitiveness and environmental standards; they relate to:
    - ◊ the productivity costs of poor environmental quality;
    - ◊ the promotion of technological leadership change; and
    - ◊ environmental protectionism.
- The productivity costs of poor environmental quality can arise through:
    - ◊ higher effective labor costs;
    - ◊ damage to other productive elements of natural capital; and
    - ◊ environmental conflict and political instability.
- The promotion of technological change is a key element of environmental policy, and technological innovation will tend to offset some of the costs of strict standards in the long run.
- However, the best way to promote innovation for environmental reasons is to price environmental damage. Other problems contributing to inadequate innovation should be targeted directly, rather than indirectly through excessively strict environmental standards.
- Environmental protectionsim manifests itself as environmental policy that discriminates against foreign producers relative to domestic producers. The distinction between environmental protectionsim and policy measures to address legitimate transboundary impacts is a difficult one to judge.
- Environmental certification is not a form of protectionsim *per se* but the imposition of uniform standards for certification can be.
- International cooperation, and the integration of environmental agreements with trade liberalization agreements is essential if the benefits of freer trade are not to be undermined by the strategic distortion of environmental policy for trade-related goals.

8.10 Related Reading

Jaffe, Adam B., Steven R. Peterson, Paul R. Portney and Robert R. Stavins (1995), "Environmental Regulations and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?", *Journal of Economic Literature*, 33, 132-163.

Kennedy, Peter W. (1994), "Equilibrium Pollution Taxes in Open Economies with Imperfect Competition", *Journal of Environmental Economics and Management*, 27, 49-63.

Palmer, Karen, Wallace E. Oates and Paul R. Portney (1995), "Tightening Environmental Standards: the Benefit-Cost or the No-Cost Paradigm?", *Journal of Economic Perspectives*, 9, 119-132.

Porter, Michael E. and Claas van der Linde (1995), "Toward a New Conception of the Environment-Competitiveness Relationship", *Journal of Economic Perspectives*, 9, 97-118.

Snape, Richard H. (1992), "The Environment, International Trade and Competitiveness", in Kym Anderson and Richard Blackhurst, (eds.), *The Greening of World Trade Issues*, The University of Michigan Press, Ann Arbor.

9. Trade, Transboundary Pollution and the Distribution of Global Wealth

9.1 Introduction

There are two important sets of international environmental linkages that pertain to sustainable global development. The first is through trade and investment; the second is through transboundary pollution (or more generally, transboundary environmental impacts). This chapter examines the interaction between these two linkages, and how that interaction relates to the distribution of global wealth.

We begin with a brief review of the transboundary pollution problem. We then relate transboundary pollution to the distortion of environmental policy for trade-related goals. Next we discuss the overall relationship between trade, transboundary pollution, and the distribution of global wealth, and examine the potential role for technology transfer in fostering global sustainable development.

9.2 The Transboundary Pollution Problem

Transboundary environmental impacts are those whose effects are felt beyond the boundaries of the country (or the province or the state) in which the source activity is undertaken. Important examples of transboundary environmental impacts include global climate change (via greenhouse gas emissions and deforestation), stratospheric ozone depletion (via emissions of chloroflourocarbons and related substances), oceanic pollution, biodiversity loss, and the effects of airborne pollutants such as particulates, sulfur dioxide and nitrous oxides.

We will cast our discussion in terms of transboundary pollution between countries but it should be noted that the same issues that are raised here also arise with respect to other levels of jurisdiction.

From an economic perspective, transboundary pollution is an *international externality*; that is, a cost imposed on other countries for which the polluting country does not have to pay. That external cost is not taken into account by the polluting country when setting its own environmental standards, and consequently, standards are set too low from the perspective of maximizing global welfare.

The problem is illustrated in Figures 9.1 and 9.2. Figure 9.1 depicts the environmental standards that would be set under a cooperative agreement between two countries. The left-hand-side vertical flows indicate the contributions of each country to transboundary pollution; the right-hand-side vertical flows indicate the impact of transboundary pollution on each country. (The case illustrated is one with symmetric contributions and symmetric impacts. We examine the asymmetric case, as between developed and developing countries, in section 9.4). Under a cooperative agreement, each country takes into account the cost of its pollution on the other country when setting its environmental standards. Note that the transboundary pollution is not eliminated under the cooperative agreement, but its level correctly reflects the balance between the costs of global environmental damage and the global cost of abatement.

In contrast, Figure 9.2 illustrates the non-cooperative equilibrium, in which each country ignores the cost that its pollution imposes on the other country. The result is one with insufficiently strict environmental standards in both countries, excessive flows of transboundary pollution, excessive environmental damage in both countries, and lower levels of welfare in both countries. (The overall welfare cost associated with the lack of cooperation is indicated by the shaded areas).

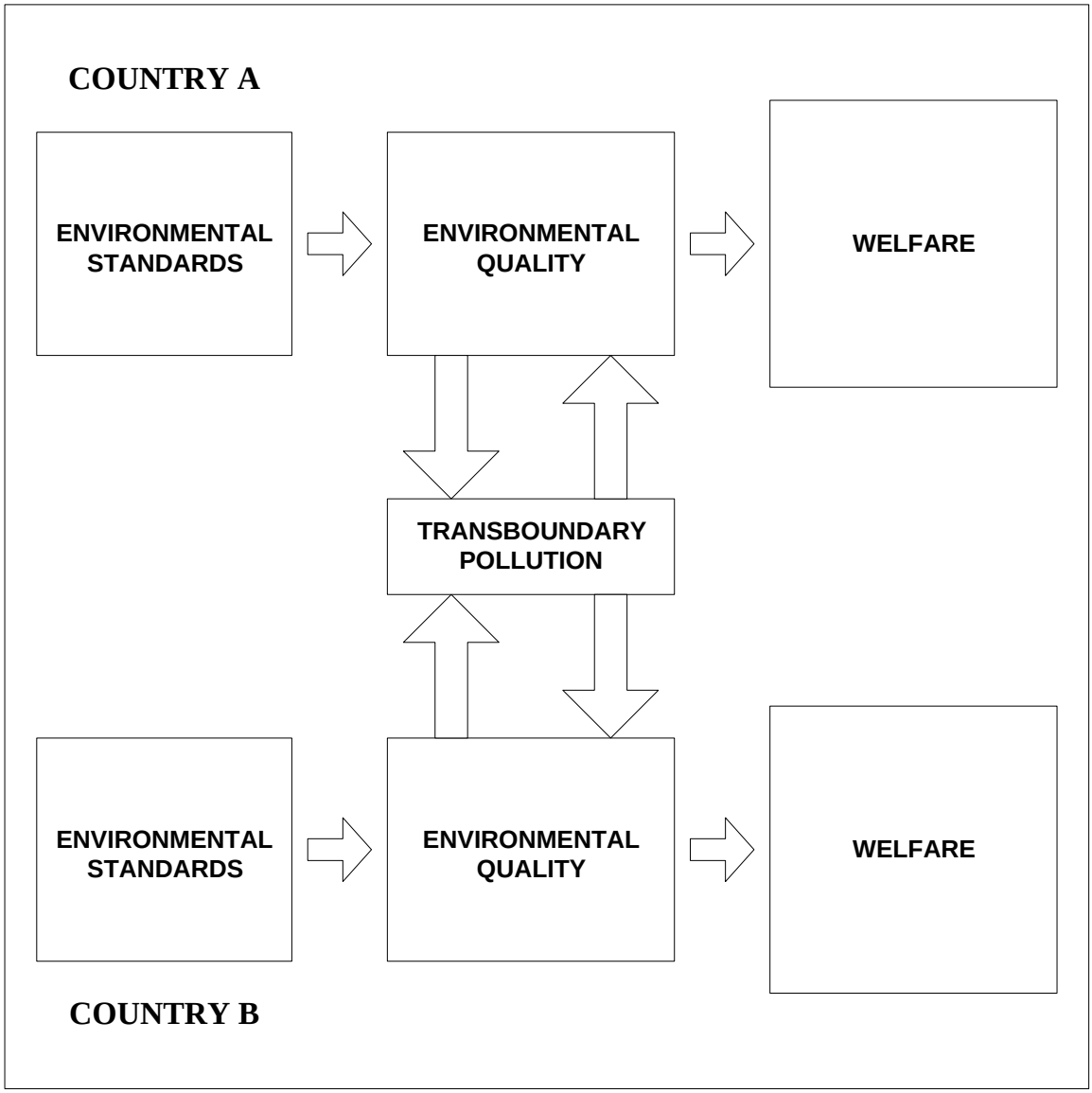

Figure 9.1

Cooperative Environmental Standards

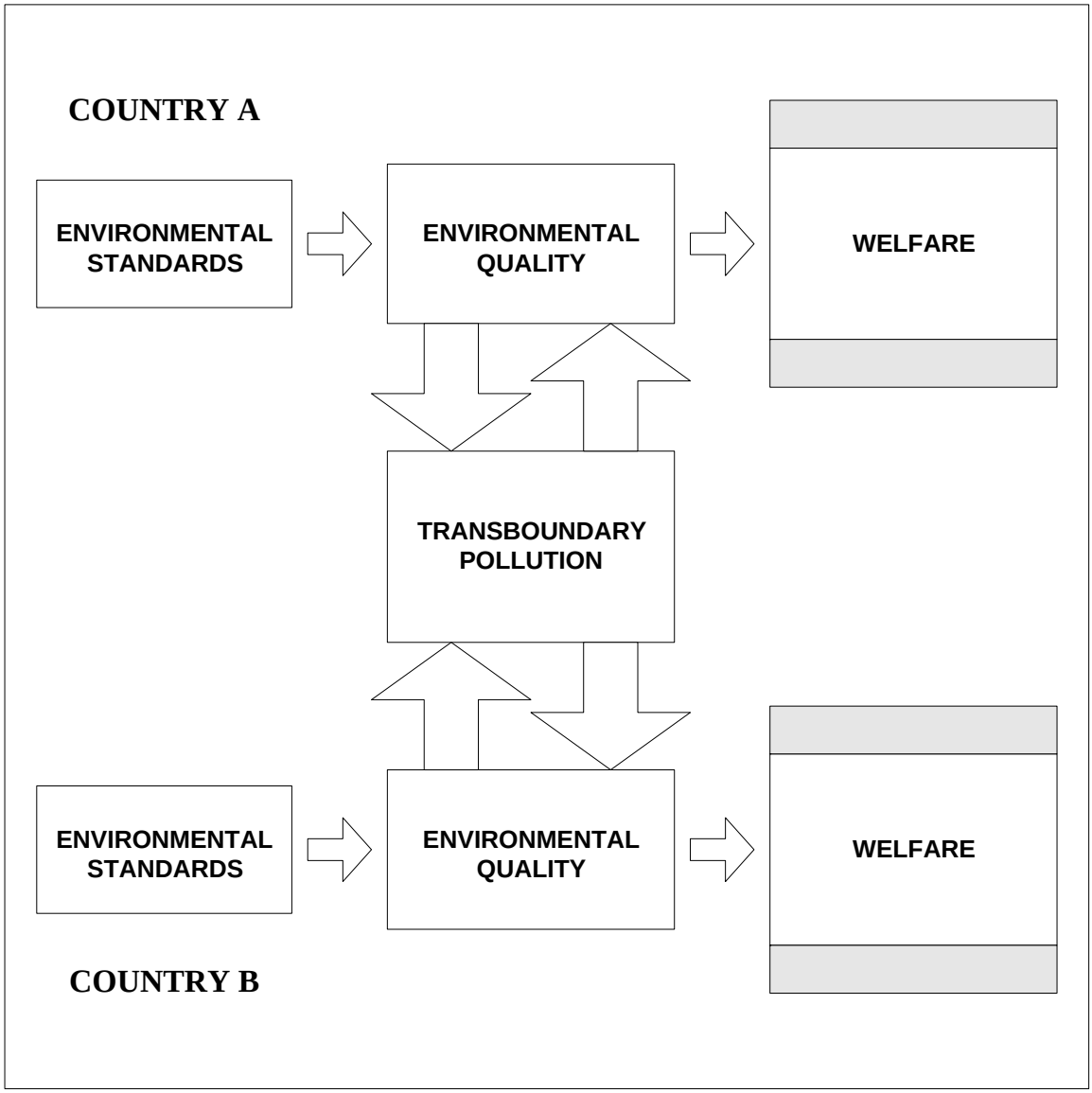

Figure 9.2

Non-Cooperative Equilibrium with Transboundary Pollution

9.3 Transboundary Pollution and the Trade-Related Distortion of Environmental Policy

Restrictions on the use of trade instruments (such as tariffs and quotas) imposed under trade liberalization agreements have the potential to cause a distortion of non-trade policies for trade-related goals. In particular, individual countries may have an incentive to relax environmental standards in order to boost their international competitiveness, and thereby capture of larger share of global economic rent.[1] This distortion of environmental policy can be magnified if there are significant transboundary pollution flows.

The problem is illustrated for the simple case of two countries in Figures 9.3 and 9.4. Figure 9.3 depicts the cooperative outcome in which both countries set environmental standards to maximize their joint welfare. In contrast, Figure 9.4 depicts the case where cooperation has broken down on two levels. First, there is no account taken of external environmental damage when setting domestic environmental standards. (This is the standard transboundary effect discussed in section 9.2 above). Second, there is an additional distortion associated with the attempt by each country to capture a greater share of global economic rent by setting weaker standards. These two distortions compound each other in the following ways. First, the rent-seeking distortion gives rise to a higher level of pollution in each country, and consequently, a higher flow of transboundary pollution. Second, the transboundary nature of the pollution means that the environmental cost to any individual country from relaxing its standards for rent-seeking goals is smaller than it would be if the entire effects of its pollution were felt within its borders. This leads it to relax its standards by a larger degree than it otherwise would. The equilibrium outcome is one with higher environmental damage and lower global welfare than would arise from either the transboundary problem or the rent-seeking problem on its own. (The overall welfare cost associated with the lack of cooperation is indicated by the shaded areas in Figure 9.4).

[1] See Chapter 8 for a detailed discussion of this point.

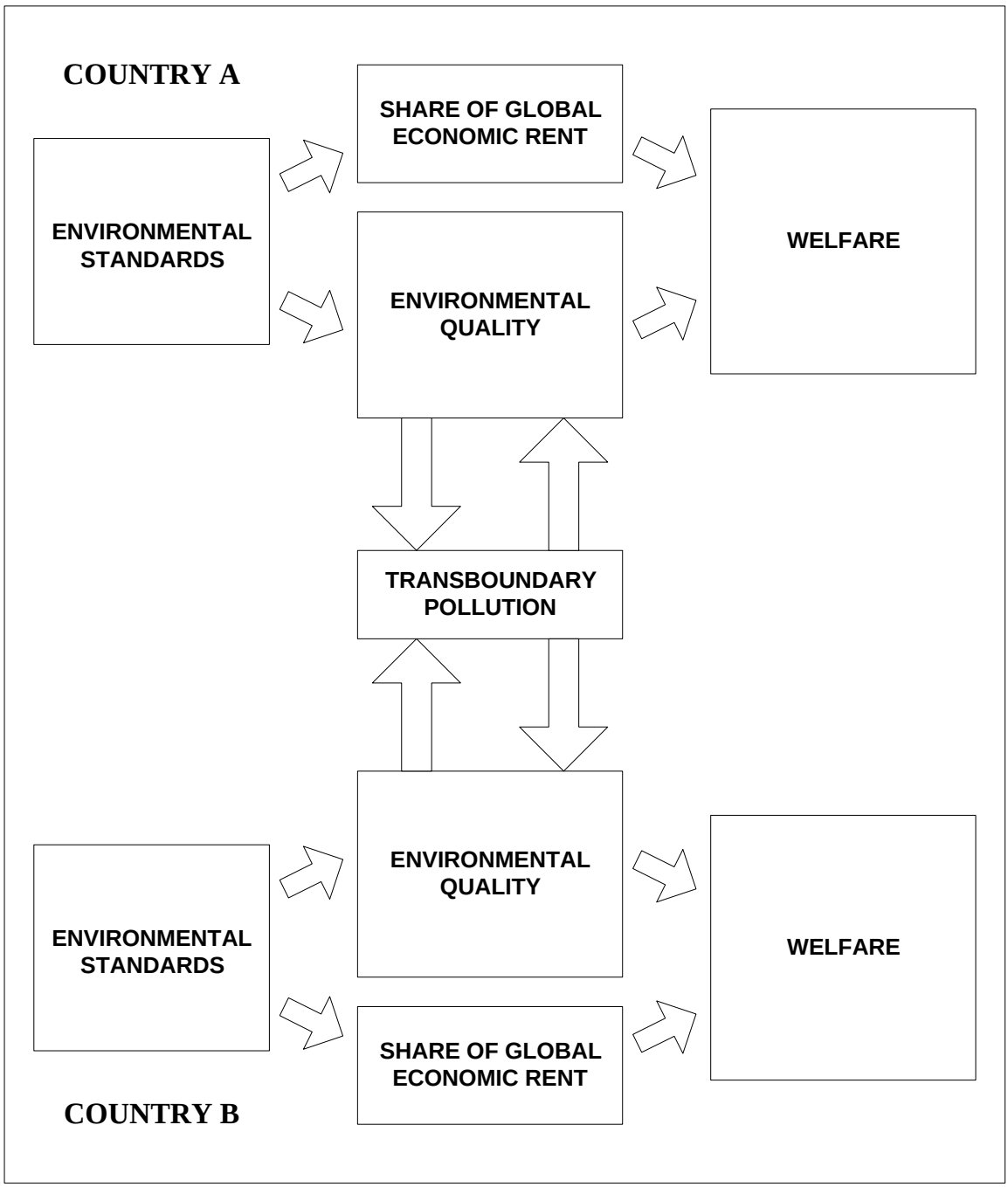

Figure 9.3

Cooperative Environmental Standards

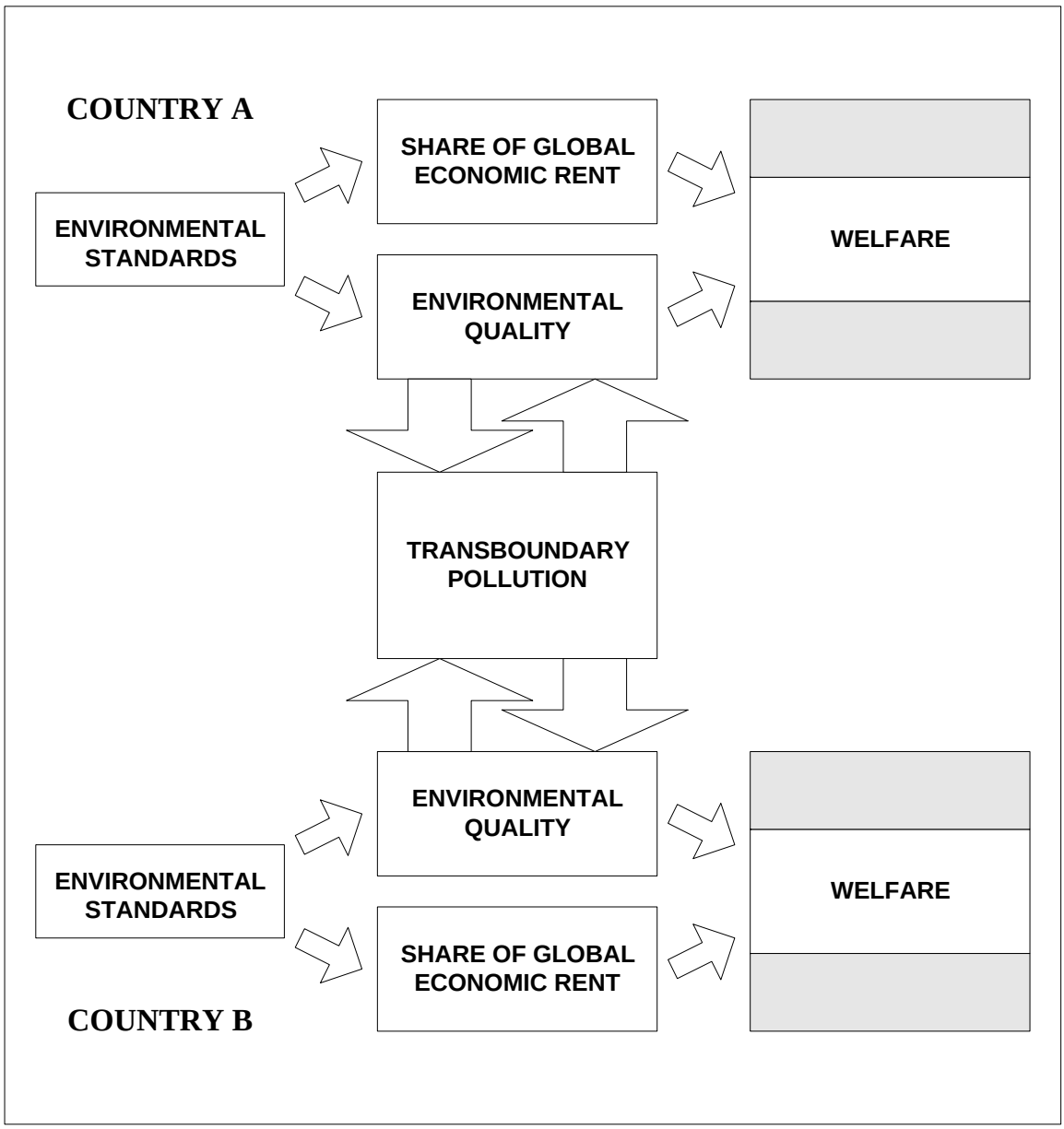

Figure 9.4

Non-Cooperative Equilibrium with Transboundary Pollution

and Distortionary Rent-Seeking

A particularly important instance of this interaction between transboundary pollution and the trade-related distortion of environmental policy is with respect to carbon dioxide emissions and their impact on global climate. Energy costs are a key component of production costs and, consequently, a key determinant of international competitiveness. Therefore, all countries have an incentive to keep their own fossil fuel prices low. In addition, global climate change is a transboundary environmental problem of the first order. The interaction of these two factors poses significant difficulties for the control of the abatement of global carbon dioxide emissions.

9.4 Trade, Transboundary Pollution, and the Distribution of Global Wealth

The previous sections emphasized the importance of multilateral cooperation with respect to environmental standards when pollution is transboundary. Such cooperation can be difficult to achieve among countries of similar wealth, but it is even more difficult to achieve in the case of countries with widely different levels of wealth. (The tension between developed and developing countries over greenhouse gas emission reductions is a visible reflection of that difficulty). The key problem is that the *coordination* of environmental standards may not be enough to achieve a globally efficient outcome; achieving global efficiency is likely to also require a *transfer of wealth* from developed to developing countries.

The point is illustrated in Figures 9.5 through 9.7. Figure 9.5 depicts the non-cooperative equilibrium between developed and developing countries. Note that contributions to transboundary pollution (the left-hand-side vertical flows) are higher for developed than for developing countries, despite higher environmental standards in developed countries. This reflects the fact that the scale of production is currently so much higher in developed countries.[2] The impact of transboundary pollution (the right- hand-side vertical flows) is

[2] See Chapter 5 for a discussion of scale effects, as distinct from technique and composition effects.

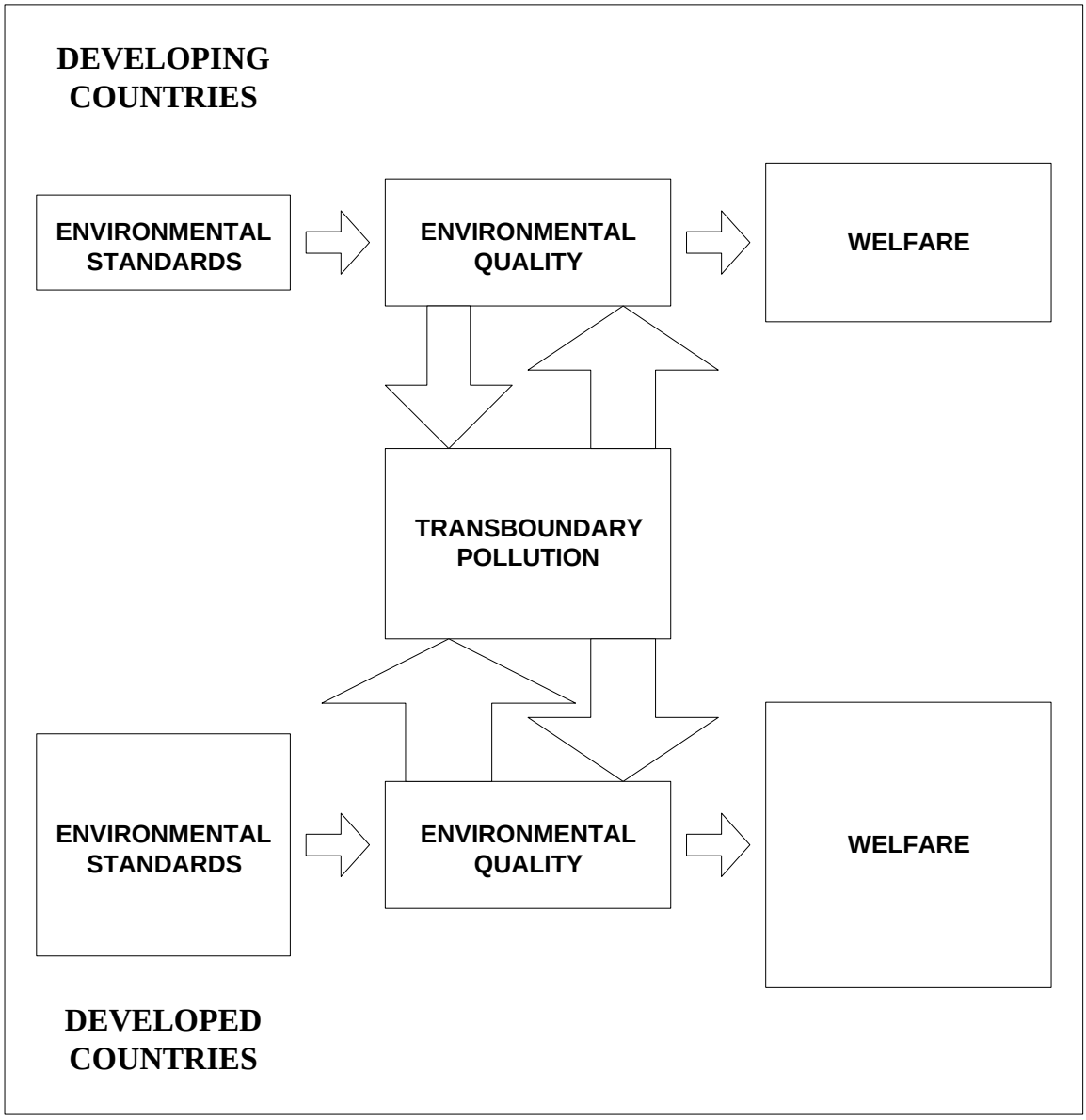

Figure 9.5

Non-Cooperative Equilibrium Between Developed and Developing Countries

illustrated as being symmetric. (We will later discuss why that may *not* be the case).

In contrast, Figure 9.6 illustrates a cooperative outcome between developed and developing countries. Environmental standards are chosen in both regions to maximize aggregate global welfare (as measured by willingness-to-pay). These standards are higher in both regions than under the non-cooperative outcome, and the associated flows of transboundary pollution are smaller. The difference reflects the externality associated with transboundary pollution and the possible distortion of environmental standards for rent-seeking goals in the non-cooperative equilibrium. The cooperation means that developed countries enjoy higher welfare than in the non-cooperative equilibrium (the gain being represented by the shaded area for that region in Figure 9.6). However, the welfare level in developing countries could actually be *lower* under the cooperative outcome than in the non-cooperative equilibrium (as illustrated in Figure 9.6, where the heavily shaded region represents the loss to developing countries). This paradoxical outcome reflects the difference in *marginal pollution abatement costs* between the two regions. The higher existing environmental standards in developed countries mean that achieving further reductions in emissions is more costly in those countries than in developing countries, where pollution standards are currently low. That is, there is less room for further improvement in developed countries. Thus, efficiency (the maximization of aggregate global surplus) calls for relatively more additional abatement in developing countries. However, the main beneficiaries of additional abatement in developing countries are the citizens of developed countries, because pollution is transboundary, and because citizens in developed countries place a higher value on improved environmental quality (due to the difference in wealth levels between the two regions). Thus, developed countries gain while developing countries could actually be made worse off. Nonetheless, *aggregate* global surplus is higher under the cooperative outcome because the gains to the developed countries more than offset the losses to the developing countries (in the sense that the winners could compensate the losers and still be better off).[3]

[3] That is, the switch to cooperation represents a *potential Pareto improvement* over the non-cooperative equilibrium.

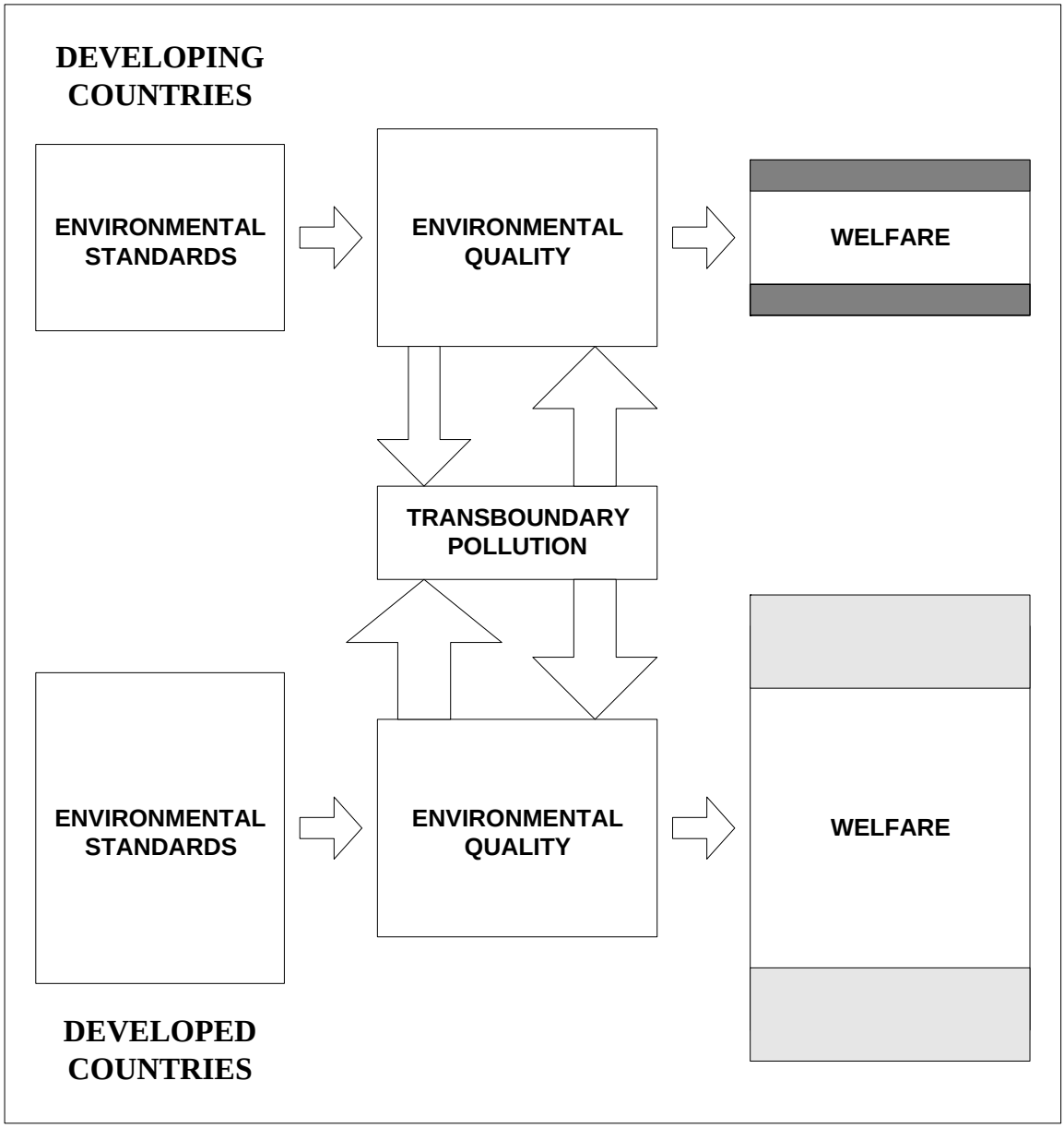

Figure 9.6

Globally Efficient Environmental Standards

There are key two points to note about these welfare effects. First, it can be argued reasonably that they are unfair, since living standards fall for the relatively poor and rise for the relatively wealthy. Second, developing countries will not agree to a cooperative agreement under which they are worse off, and this presents an obvious impediment to achieving globally efficient environmental standards. One "solution" to these problems is for the relative burden of pollution abatement to be placed more heavily on developed countries. However, this solution ignores the very real difference in abatement costs between developed and developing countries. A better solution, though perhaps a politically more difficult one, is to base relative abatement requirements on relative abatement costs (as required for global efficiency), and to address the adverse welfare effect for developing countries with direct "side payments" (wealth transfers) from developed to developing countries. This solution is illustrated in Figure 9.7. Relative abatement requirements in the two regions are set to fully exploit relative abatement costs, and the associated gains are redistributed in such a way as to make both regions better off than in the non-cooperative equilibrium (by the amount of the shaded areas in Figure 9.7).

It must be stressed that it is the self interest of developed countries to make these redistributive side payments; it is not a matter of international charity or compensation for past injustices. The side payments are essential to bring developing countries into a bargaining solution from which developed countries gain more than they lose. Any cooperative agreement that does not allow for side payments is likely to be inferior for all parties concerned.

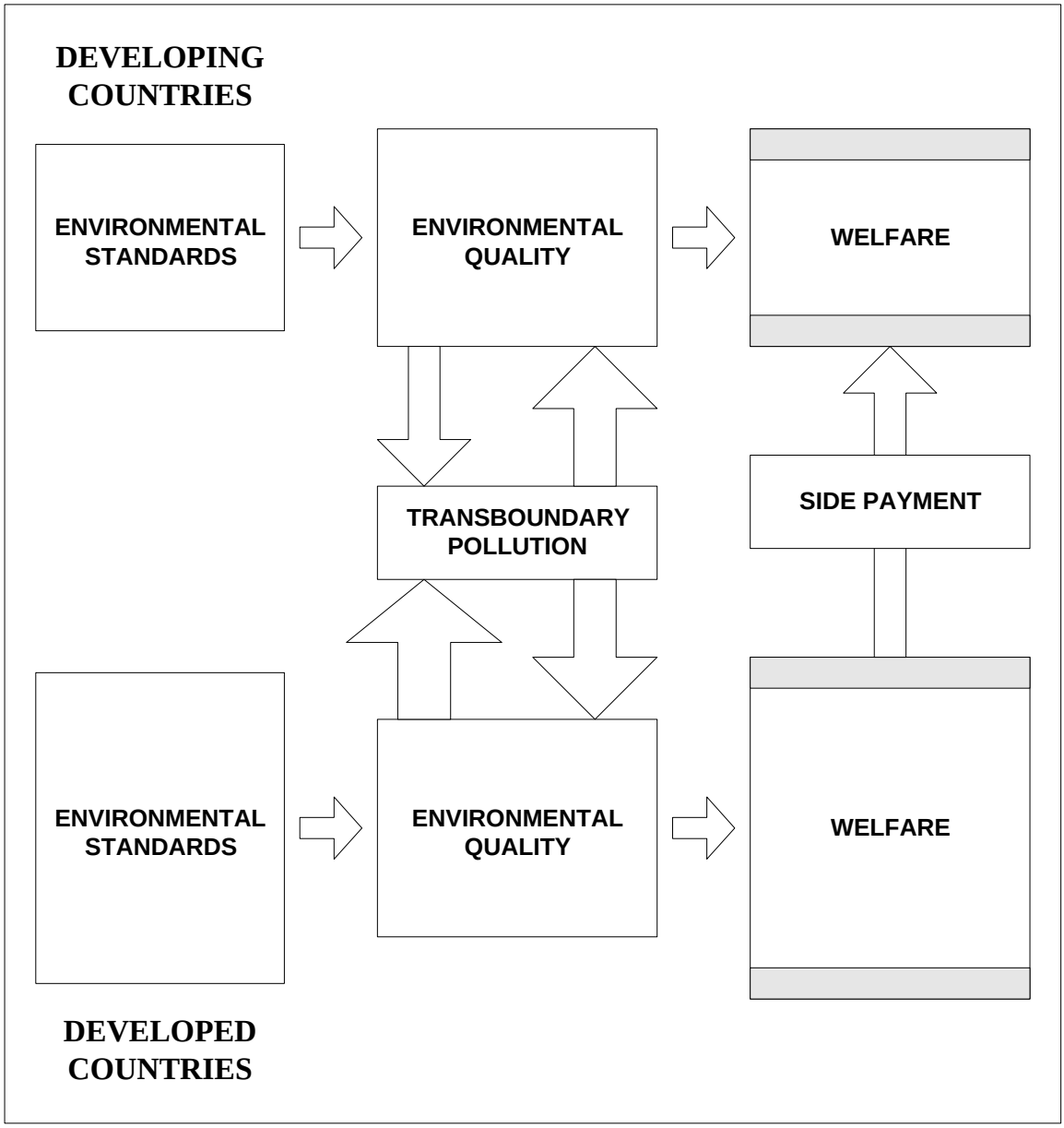

Figure 9.7

Global Efficiency Supported with Side Payments

Technology Transfers

While a cooperative agreement with side payments can yield significant gains to both developed and developing countries, it will in general still not produce the best possible outcome from a global perspective. The "first best" outcome is likely to involve technology transfers; that is, a sharing of knowledge capital. Unlike other forms of economic capital, knowledge capital is a *public factor*, once it is produced. That is, its use by one producer does not detract from the ability of other producers to use it also. This means that cleaner production technologies could in principle be transferred from developed countries to developing countries to the benefit of both (since both regions gain from a reduction in transboundary pollution).

There are two major obstacles to these technology transfers. First, while knowledge is a public factor once it is created, it will not be created unless the creator is able to appropriate at least some of the gains from its creation. If all new ideas were to enter the public domain immediately after their conception then there would be very little incentive for firms and individuals to devote resources to the creative process. The advancement of knowledge would slow dramatically and all future people would be worse off. The continual advancement of knowledge is crucial for sustainable development. Thus, there must be limits set on the rate and extent of technology transfers from developed to developing countries in order to create *dynamic incentives*.

The second major obstacle to technology transfers relates to trade and competitiveness. Firms in possession of leading technologies capture economic rent from those technologies. (That rent may simply be a "fair" return on previous research investments, but is it nonetheless an *ex post* rent in the sense that the return exceeds current production costs). We have seen (in section 9.3) that such rents can lead countries to distort environmental standards in an attempt to capture a larger share of them. In addition, these rents mean that countries in possession of leading technologies have an incentive not to share those technologies with their trading partners (quite apart from any dynamic incentive considerations). Thus, the rate of technology transfer between developed and developing countries is likely to be lower in equilibrium than it should be from a global

welfare perspective. In this respect, strategic trade considerations can be a serious impediment to sustainable development.

Note that the problem here is not trade *per se*, but rather, the strategic interaction between countries created by trade in imperfectly competitive global markets. The solution again is cooperation. Both developed and developing countries could be made better off with a balanced mix of compensated technology transfer, significant transboundary pollution abatement in developing countries, and quite probably, side payments from developed to developing countries.

Asymmetric Transboundary Damage

The foregoing discussion implies that the transboundariness of pollution gives developing countries some element of bargaining power in trade and environmental agreements, since developed countries benefit when developing countries reduce their emissions. However, the extent of that bargaining power depends on whether or not the impact of transboundary pollution is symmetric between developed and developing countries. In particular, if the impact of transboundary pollution falls more heavily on developed countries then that bargaining power is strengthened. Conversely, if the impact falls more heavily on developing countries then that bargaining power is weakened. In many instances, the burden of transboundary environmental impacts are in fact likely to fall more heavily on developing countries. There are two reasons for this. First, the ability for a country to take mitigating action against damage (for example, by taking protective action against the adverse affects of climate change) is directly related to its stock of knowledge, which is relatively more abundant in developed countries. Second, and this is related to the first, developing countries are typically more natural-capital dependent than developed countries, so unmitigated environmental damage will have a greater impact on productivity in developing countries.

9.5 Conclusion

We have seen (in section 9.3) that transboundary pollution can exacerbate the strategic distortion of environmental standards for rent-seeking goals, and that strategic trade goals can in turn impede the transfer of cleaner technologies from developed to developing countries (section 9.4). These aspects of the trade and environment linkage make the need for global cooperation even more imperative. However, the mutual benefits that can arise from that cooperation may still not be enough to allow sustainable development for all people of the world. Achieving sustainable development in developing countries is likely to require some real short term sacrifices by citizens of developed countries. The liberalization of trade between developed and developing countries should be viewed as an important step towards achieving global sustainability but not as a complete panacea.

9.6 Synopsis

- Transboundary pollution is an international externality; that is, a cost imposed on other countries for the which the polluting country does not have to pay.
- External cost is not taken into account by the polluting country when setting its own environmental standards, and consequently, standards are set too low from a global perspective.
- Transboundary pollution can exacerbate the strategic distortion of environmental policy for trade-related goals because the environmental cost to any individual country of reducing its standards is less than the true global cost.
- International cooperation and policy coordination are essential to overcome the problems of transboundary pollution and the strategic distortion of environmental policy for trade-related goals.
- Policy coordination alone may not be enough to achieve global efficiency since differences in marginal abatement costs may mean that some countries should abate relatively more than others in order to minimize global abatement costs.

- Attainment of global efficiency may require compensating side payments from developed to developing countries in return for greater abatement by developing countries.
- Wealth transfers from developed to developing countries should ideally take the form of knowledge transfers. There are two main obstacles to such transfers:
    - ◊ the need to create incentives for innovation through the *ex post* patent protection of new technologies; and
    - ◊ the possible erosion of global competitiveness for the existing owners of the knowledge.
- The bargaining power of developing countries in negotiations over transboundary pollution and knowledge transfer is limited by the likelihood that developing countries are likely to suffer more from transboundary pollution problems, such as global climate change, than are developed countries.

9.7 Related Reading

Copeland, Brian R. and M. Scott Taylor (1995), "Trade and Transboundary Pollution", *American Economic Review*, 85, 717-737.

Kennedy, Peter W. (1994), "Equilibrium Pollution Taxes in Open Economies with Imperfect Competition", *Journal of Environmental Economics and Management*, 27, 49-63.♠

Krugman, Paul and Anthony J. Venables (1995), "Globalization and the Inequality of Nations", *Quarterly Journal of Economics*, 110, 857-880.

♠ This reading is included with those for Chapter 8.

10. Economic Incentives, Environmental Regulation, and Trade

10.1 Introduction

The growth and structural change that come with trade liberalization can have significant effects on the flow of resources within an economy, and consequently, on environmental quality. Capturing the full benefits of trade liberalization requires that those effects be properly managed with well-designed policy, both at the individual country level and at the international level. The objective of policy should not be to retard economic change *per se*, but rather to ensure that change occurs at a pace and in a manner that is consistent with a farsighted vision of sustainable development. This in turn means that the policy design problem is not a static one, but an ongoing dynamic one.

This chapter provides a brief overview of environmental regulation. We begin with a discussion of some general principles with respect to environmental policy design. We then examine three broad classes of policy instruments ("command-and-control", "economic instruments", and "other policy instruments") and describe their most significant properties. We then discuss two potential impediments to the application of policy instruments: political obstacles, and the costs of monitoring and enforcement. Finally, we consider the implications of trade and competitiveness considerations for the design of environmental policy.

10.2 General Principles for Environmental Policy Design

There are two basic paradigms with respect to policy intervention in an economy. One is the *central planning paradigm*, wherein the allocation of resources is determined

principally by a central planning authority. The increasingly dominant alternative to central planning is the *regulated market paradigm*, wherein resource flows are determined principally by decentralized market forces, but those forces are regulated and shaped, to varying degrees, by policy intervention. Our interest here is with the regulated market paradigm.

The basic framework for policy intervention in a market-based economy is illustrated in Figure 10.1. The policy problem is to implement a *resource allocation target* as a *corrected market equilibrium* through the application of *policy instruments* to change the *incentives* of the economic agents.

The Resource Allocation Target

The particular resource allocation target is set by government. From an economic perspective, one element of that target should be *economic efficiency;* that is, the target allocation should be such that it would *not* be possible to switch from the target allocation to an alternative allocation in which everyone in the economy (both now and in the future) would be better off than in the target allocation.[1] Economic efficiency does not isolate a unique optimal resource allocation; many allocations can satisfy the efficiency criterion. The key difference between different efficient allocations relates to the *distribution of wealth* across individuals. Thus, a resource allocation target must generally also have a distributional element; that is, some notion of "fairness". Sustainable development is such a target; it has both an efficiency element and a distributional element (in both intragenerational and intergenerational terms).

[1] Strictly speaking, an allocation is efficient if it is not possible to switch to an alternative allocation in which at least one person is better and no individual is worse off.

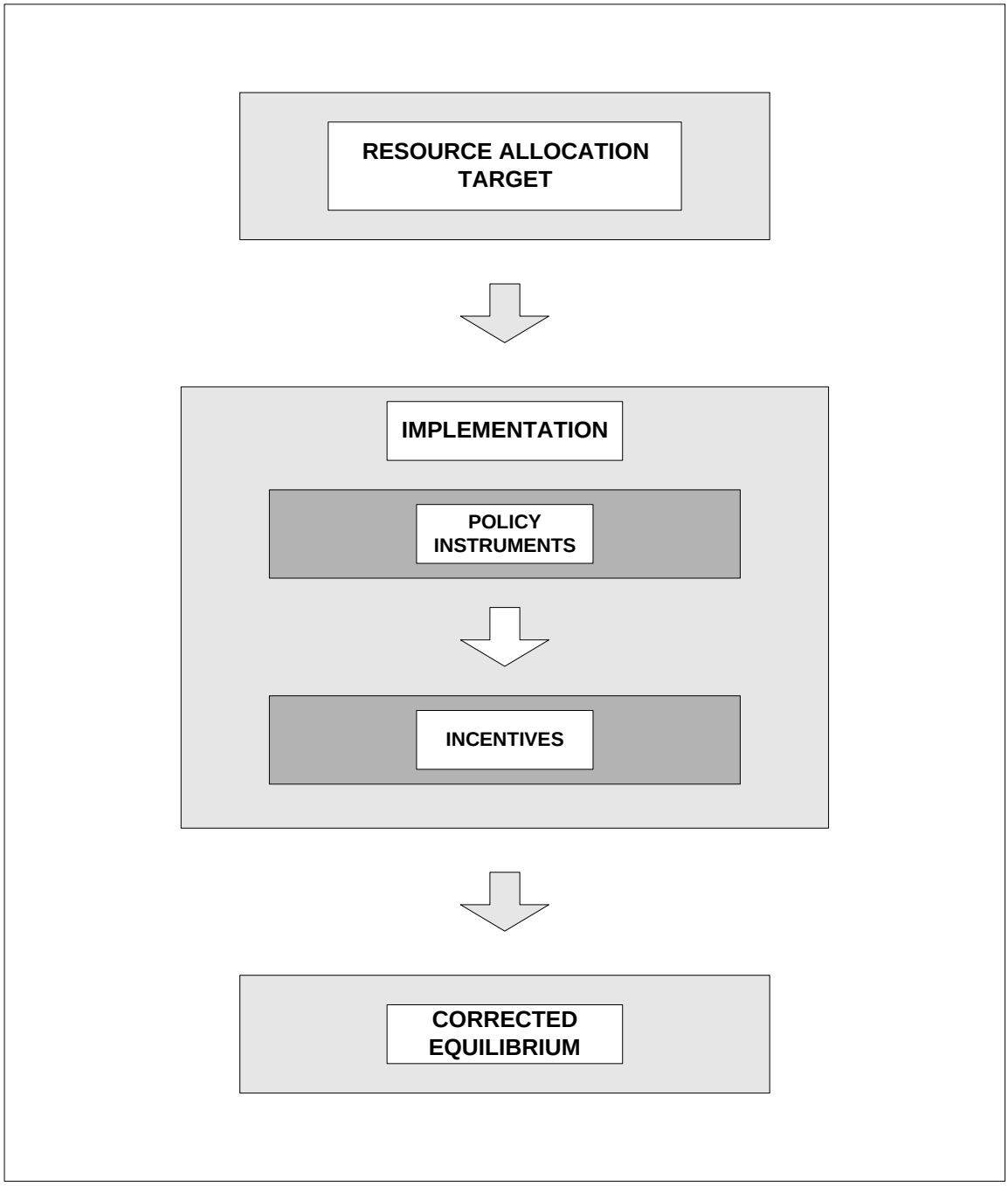

Figure 10.1

The Policy Design Problem

Implementation of the Resource Allocation Target

The next step in the policy design problem is to implement the chosen resource allocation target through the application of policy instruments. This should be viewed as a two tier problem, as illustrated in Figure 10.2. The first tier comprises the choice of *regulatory regime*; that is, the general regulatory framework to be used. That choice is sometimes characterized as a binary one, between command-and-control regulation (under which individually set standards are enforced by threat of penalty) and economic instruments (wherein pollutants are assigned a price to be paid by polluters). This is an unnecessarily restrictive characterization. While we will argue below that economic instruments have much to recommend them over command-and-control regulation, there are some instances where command-and-control may be a better choice. Moreover, other policy instruments, such as legal liability and information disclosure, can also play an important role in implementation. Thus, we will think of the regulatory regime choice problem as one of choosing a particular mix of command-and-control, economic instruments, and other policy instruments. Note that the optimal mix may change over time as the economy changes.

The second tier problem is the choice of *instrument values.* For example, if individual standards form part of the regulatory regime, how restrictive should those standards be? If emission fees are to be used as part of the regulatory regime, at what value should those fees be set? If information disclosure is to be used, what should be the scope of that policy instrument, for example, in terms of eco-labeling versus formal certification?

Another important aspect to the choice of instrument values relates to the point at which an instrument should be targeted. In general, the policy instrument should be targeted at the source of environmental damage. For example, if the mercury content in an industrial effluent is the source of damage, then the policy instruments should target the mercury and not the effluent per se, which could in fact be mostly water.

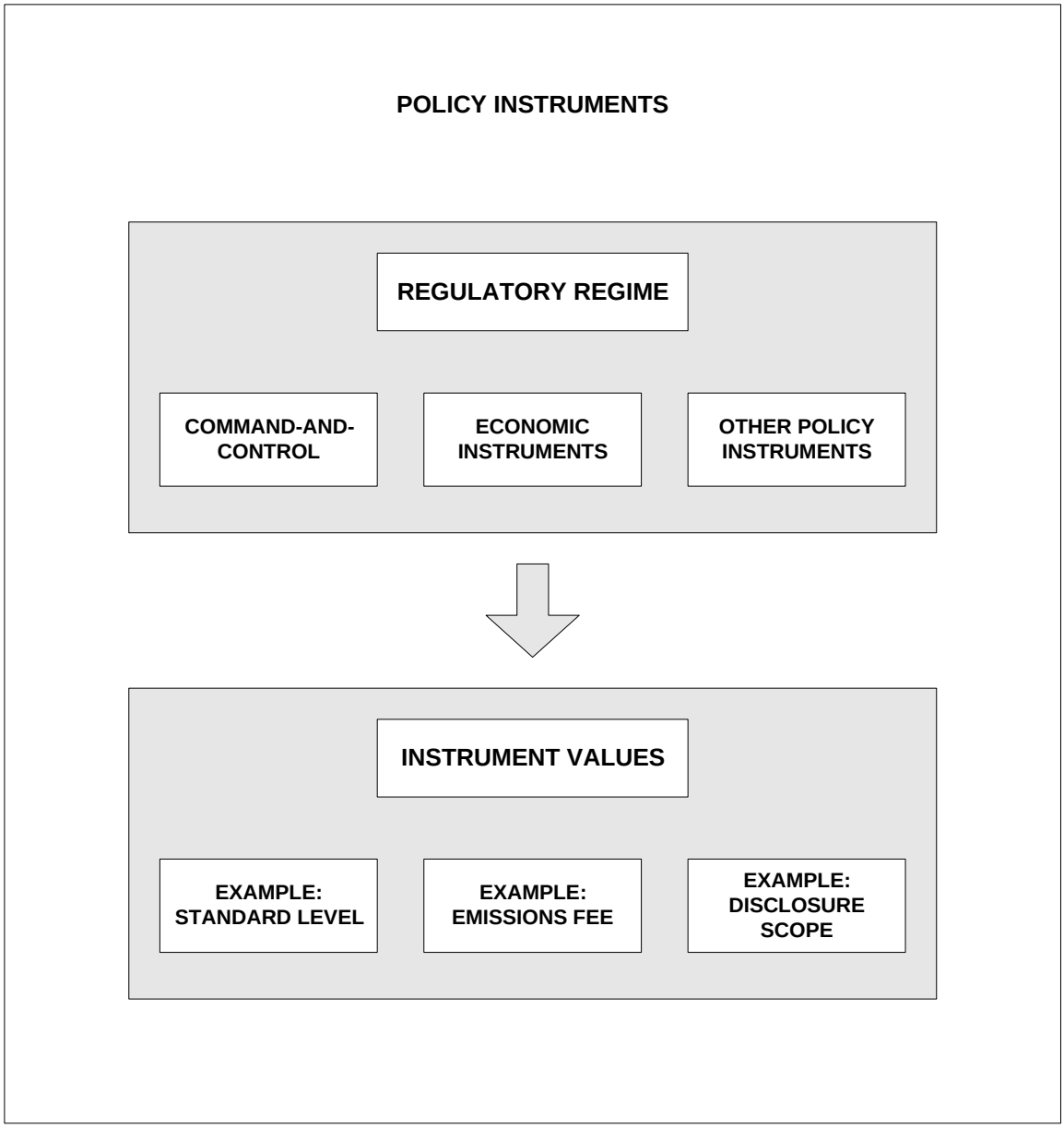

Figure 10.2

Implementation of the Resource Allocation Target with Policy Instruments

It is generally easier for a regulator to adjust instrument values over a short time-span, than to adjust the regulatory regime, and for this reason, one important consideration in the choice of regulatory regime is the flexibility it affords in terms of setting instrument values.[2] Cost-effectiveness and incentives for cleaner technology adoption are also key considerations. In the next three sections we examine the main properties of each of the policy instrument classes that make up a regulatory regime.

10.3 Command-and-Control Regulation

The key characteristic of command and control (CAC) regulation is that the regulator specifies what individual firms can and cannot do, enforced by the threat of penalties for non-compliance. The different forms of CAC regulation can be classified into two main types:

- performance standards; and
- design standards.

Performance Standards

Performance standards place restrictions and conditions on the day-to-day performance of the regulated source (such as a firm). Performance standards may include restrictions on the volume of emissions per unit of time, restrictions on the volume of emissions per unit of output or input, restrictions on the use of polluting inputs or mandated use of non-polluting inputs, and less commonly, restrictions on output.

Among the different types of performance standards, emission standards are generally the preferred instrument. These put restrictions on the volume of emissions per unit time (such as a month). Emission standards have two main advantages over other performance standard types, such as emissions-per-output standards or input standards. First, emissions standards give the regulated source more *flexibility* in meeting its target level

[2] That is not to say that more flexibility is always better; *commitability* often has important strategic value for a regulator.

of emissions. The source will therefore choose the least-cost method to meet its target. Second, other types of standards can actually have *perverse effects* if not set very carefully. For example, an emissions-per-unit-input standard could potentially lead to a higher level of emissions than without regulation because the regulated source may find it advantageous to increase its use of the tied input to the extent that allowable emissions actually rise.

In general, performance standards should target the source of environmental damage as closely as possible. If emissions are the source of damage then the standard should restrict emissions, and not some related variable, like emissions-per-unit-input. However, in some instances, such as with non-point source pollution and mobile source pollution, measuring emissions may be prohibitively difficult. In such cases it may be better to target a related input, even if there is not a fixed relationship between the input and emissions. For example, nitrogen pollution from fertilizer use is notoriously difficult to trace to its source application. So, even though nitrogen leaching into waterways is the source of damage, the "second best" policy may be to restrict the application of fertilizer, or restrict the nitrogen content of fertilizer.

Design Standards

Design standards (or technology standards) impose requirements for the use of particular pollution control equipment (such "scrubbers" on coal-fired power station smokestacks), or a particular production technology (such as oxygen bleaching for pulp and paper production).

The use of design standards is often motivated by a "pollution prevention" goal; that is, a belief that it is better to reduce the creation of pollution than to control and regulate it once it is created. The main argument in favour of this approach is that the monitoring of technology standards is often much easier than the monitoring of performance standards. However, it must be stressed that the existence of a cleaner technology does not necessarily mean that its adoption is worthwhile. The social benefits of adopting a cleaner technology, in the form of reduced damage, and reduced monitoring costs, must

be weighed against the costs. Switching technologies, such as moving from chlorine bleaching in pulp paper production to oxygen bleaching, or moving from secondary wastewater treatment to tertiary treatment, can be extremely costly. The resources devoted to that technology change may be better devoted elsewhere if the benefits are not substantial. Moreover, the irreversibility of switching technologies means that in some instances it may be better to delay adoption of a cleaner technology until an even cleaner one becomes available. Thus, while the adoption of cleaner technologies holds the long-term key to sustainable development, adoption decisions at any point in time must be based on sound cost-benefit analysis.

Uniform Standards and Cost-Effectiveness

Standards, of all types, have two major drawbacks. First, they are generally not a cost-effective instrument for achieving aggregate emission targets. Least-cost implementation of an aggregate emissions target requires that sources who find it least costly to cut their emissions should undertake a relatively higher level of abatement than sources for whom abatement is very costly. Thus, the imposition of uniform standards, without regard to differences in abatement costs across sources, will generally not be cost-effective. In principle, standards can be set non-uniformly across sources, based on their abatement costs. In practice, it is extremely difficult for the regulator to acquire enough information about the abatement costs of individual sources to set non-uniform standards optimally.

Second, standards do not put a price on emissions below the level of the standard. Yet any level of emissions beyond what can be assimilated causes damage. There is therefore a real social benefit to further emission reductions below the level of the standard, and if reductions can be achieved at a cost less than that benefit (either through “end-of pipe” abatement measures or through the adoption of cleaner technologies), then those reductions should be made. However, a standard generally does not create the correct incentives for the source to undertake those emission reductions, since the source pays no price for emissions below the level of a binding standard.

10.4 Economic Instruments

"Economic instruments", or "market-based instruments", refers to a class of policy instruments that attach an explicit price to pollution. These instruments may assign a price to pollution directly, such as through an emissions fee, or they may do so indirectly, such as through an emissions trading program. Economic instruments have a number of potential advantages over command-and-command instruments, the most important of which are:

- the creation of ongoing incentives for abatement and cleaner technology adoption; and
- least-cost implementation of aggregate targets with fewer regulatory information requirements.

The key feature of economic instruments that underlies these advantages is the pricing of pollution. There are three main types economic instrument, each of which puts a price on pollution:

- emission fees;
- tradeable emission permits and tradeable emission reduction credits; and
- deposit-refund type schemes.

Emission Fees

Emission fees assign an explicit price per unit of emissions. For example, a fee of $50 per ton may be assigned to emissions of effluent solvent from an industrial plant. Emission fees have the potential to implement an aggregate emissions target at least cost because all sources face the same emissions price. Thus, by each source finding the balance between its own marginal abatement cost and the emissions price, marginal abatement costs are indirectly brought into equality across sources. This means that total abatement cost cannot be further reduced for the given aggregate emission target.

An abatement subsidy paid to polluters has an incentive effect for an individual polluter similar to that associated with an emissions tax. However, there are two key differences

between emission taxes and abatement subsidies. First, at an industry level, an abatement subsidy can encourage excessive entry, and can therefore potentially have a perverse effect on aggregate emissions. Second, the payment of an abatement subsidy implicitly assigns the property rights over assimilative capacity to the polluter. This has important political implications, and equally important implications for government revenue and expenditure.

The main drawback with emission fees relative to command-and-control standards is the difficulty of ensuring that the aggregate emissions target is achieved, since this requires setting the right price in relation to abatement costs, about which the regulator usually does not have good information. Of course, an emissions fee should ideally be set to price actual environmental damage, rather than to implement a particular aggregate emissions target *per se*. In many cases (where marginal environmental damage is constant), setting that price does not require knowledge of abatement costs.

Emissions Trading

In principle, emissions trading can overcome the informational problem with emission fees. A tradeable emission permit scheme sets the quantity of aggregate emissions directly, by assigning a specific number of permits. Allowing those permits to be traded between sources then establishes a market price for those permits, and if sources face the same price (that is, if the permit market is "competitive"), then marginal abatement costs are brought into balance across sources, just as they are under an explicit emission fee scheme.[3]

Emissions trading schemes require "deep" markets in order to function well; that is, the market for emissions should involve many different sources, each being small relative to the entire market. However, even where these conditions do not hold, scaled down versions of emissions trading that only allow direct "trades" across sources, can yield substantial cost savings in the implementation of an aggregate emissions target.

Deposit-Refund Schemes and Environmental Securities

Deposit-refund schemes have commonly been applied to beverage containers as a policy for reducing litter. However, their applicability is actually much wider. The basic idea is to attach a deposit to the price a good (such as a beverage container) that is paid by the consumer upon purchase and refunded to the consumer if the waste product from the good is returned. If the deposit is set equal to the difference between the cost of the least-cost disposal method (which may be recycling or refilling) and the cost of the disposal method that the consumer would otherwise have used (such as landfilling), then it creates the right incentives for the consumer to return the waste product. This scheme can be applied to a wide variety of goods, including paints, used motor oils, car tires, etc.

A variation on the deposit-refund scheme is an *environmental security scheme*. This instrument can be usefully applied where there is some risk that a particular activity or development will cause environmental damage. The security (or "bond" or "assurance"), paid before the activity is undertaken, is refunded if, and only if, no damage occurs. For example, an oil tanker may be required to pay a security prior to entering national waters, and that security is refunded only if no oil spill occurs while it is in those waters. Similarly, a mining development may be required to post a security that is refunded only if appropriate reclamation work is undertaken upon completion of the project. The security creates an incentive for the potential polluter to engage in appropriate precautionary action to prevent an environmental accident from occurring.

10.5 Other Policy Instruments

There are a wide range of other instruments available to regulators, some formal, some informal (such as political suasion). Two that are worthy of particular note are:

- legal liability; and

[3] *Tradeable emission reduction credits* are a variation on tradeable emission permits, whereby a source can sell (or "bank" for later use under some schemes) the credits it receives for cutting its emissions.

- information disclosure schemes.

Legal Liability

Allowing individuals to litigate against the source of environmental damage from which they have suffered can provide powerful incentives for potential sources to avoid causing that damage in the first place.[4] In many ways, assigning financial liability for damage acts in much the same way as assigning an explicit price to that damage, as in an emission fee scheme. Of course, the court system can be a very costly institutional mechanism for the (indirect) implementation of policy, and for this reason, the role of legal liability is limited. Moreover, the efficacy of legal liability in creating incentives relies on a well-functioning legal system, to which damaged parties must have reasonable access regardless of their wealth. Allowing "class action suits", wherein a group of damaged individuals take a joint action against a defendant (thereby spreading the legal costs) can improve that access, but courts are nonetheless often the exclusive domain of the wealthy, in both developed and developing countries.

Information Disclosure

Information disclosure seeks to harness the potential power of "green consumerism" in creating market incentives for environmental damage control. Many consumers would be willing to pay a higher price for a cleaner product, or to avoid an environmentally damaging product, if they were well-informed about the environmental profiles of those products. The objective of information disclosure is to provide that information. "Eco-labeling", certification schemes, and the publication of "polluter blacklists" are all based on this idea.[5] Information disclosure can also be effective when directed at investors, who may choose to avoid certain companies for "ethical" reasons, or out of concern that sales will decline when consumers become informed about their products, or out of concern that the company may be a potential target for a regulatory action.

---

[4] Note that this is distinct from the government taking a polluter to court for violation of a regulation. The ability of the government to enforce its regulations under the law is elementary to any environment policy regime.

[5] See Chapter 8 (section 8.6) for further discussion of certification schemes and their potential role in environmental protectionsim.

Information disclosure schemes have considerable potential as an environmental policy instrument. However, it must be remembered that the provision of information does not internalize the externality (that is, the unpriced cost) that one consumer imposes on another when they consume an environmentally damaging product. For this reason, information disclosure policy should be used as an adjunct to other polices, such as standards, emission fees and deposit-refund schemes, rather than as a substitute for them.

10.6 Impediments to the Application of Policy Instruments

There are two main impediments to the application of environmental policy instruments:

- political obstacles; and
- monitoring and enforcement costs.

These problems are not unique to environmental regulations but they nonetheless require careful consideration in the design of an environmental regulatory regime.

Political Obstacles

The list of political obstacles to implementing environmental regulations could easily fill a book. Here we wish to focus on just one: equity considerations. This often arises as an important issue with respect to the choice between the use of economic instruments, and command-and-control. In particular, it is sometimes argued that uniform standards are a "fairer" form of policy instrument than economic instruments because the explicit pricing of pollution means that the relatively wealthy are able to pollute more, and yet the costs of pollution often fall disproportionately on the poor.

Two points need to be made in response to this critique of economic instruments. First, the inefficiency associated with uniform standards (that is, the higher than necessary aggregate cost of meeting a given pollution target) means that resources are being wasted that could otherwise potentially have been devoted to improving the lot of the poor.

Second, while the costs of environmental degradation do typically fall most heavily on the poor, this is true regardless of which regulatory instruments are used to implement a given environmental goal. With implementation via economic instruments, relatively wealthy polluters will at least be paying a price for the environmental damage their activities cause. In contrast, the implicit price of meeting a given environmental goal under uniform standards is often spread more evenly across the wealthy and the poor. The outcome under economic instruments is in fact likely to be more equitable in many instances than under uniform standards, especially if the revenue collected from pollution taxes and fees is used to mitigate the impact of pollution on the poor.[6]

Monitoring and Enforcement Costs

No environmental regulation is effective if it is not complied with, and fostering compliance generally requires monitoring and enforcement (M&E). The costs of M&E are typically not systemically higher or lower under any particular form of policy instrument. However, there are two general points to consider with respect to the relationship between instrument types and values, and M&E costs.

First, while targeting the source of damage is in general a good guiding principle for policy, M&E cost considerations may sometimes necessitate a different approach. This is particularly true with respect to non-point source pollution, and mobile source pollution. For example, the application of a potentially polluting fertilizer to crops may cause damage only if there is drainage into a waterway, which depends on individual application practices and natural drainage patterns. These will generally differ across farms, so not all fertilizer applications are "equal" in terms of their polluting effect. However, it is usually impossible to trace drainage into a waterway to particular farms,

[6] In principle, any transfers to the poor (whether funded by pollution taxes or otherwise) should be untied, thus allowing individuals to spend those funds on activities of highest value to them. However, there are at least three arguments in favour of tying pollution tax revenue to pollution mitigation. First, it improves the political "optics" of imposing the taxes. Second, direct compensation to parties affected by pollution can undermine their private incentives to undertake mitigation. Third, pollution mitigation is a public good and will tend to be under-supplied if left to voluntary contributions from individuals. Nonetheless, if pollution tax revenue is used to fund public projects for the poor then it should be directed at projects with the highest net benefit, which may or may not be pollution mitigation schemes.

since drainage does not emanate from particular identifiable point sources. In such situations it may be better to tax or limit fertilizer use, even though drainage into waterways, rather than fertilizer use *per se*, is the source of environmental damage. A similar issue arise with respect to mobile source pollution, such as nitrous oxide emissions from automobiles. These emissions are related as much to engine condition and driving patterns as they are to gasoline use. However, it is much easier to monitor and tax gasoline use than to monitor and tax nitrous oxide emissions at the tailpipe.

Second, compliance with design requirements is sometimes easier to verify than compliance with performance requirements. This is typically the case where production equipment or abatement equipment cannot be disengaged once installed. On the other hand, performance compliance is easier to monitor (such as through periodic water quality testing) than design compliance if disengagement and reengagement (just prior to an inspection) is relatively easier.

The design of the M&E policy itself is of course an important determinant of its cost. There are a number of key issues to consider in this respect. First, polluters respond to the magnitude of the *expected penalty* for non-compliance. Roughly speaking, the expected penalty is equal to the value of the actual penalty for non-compliance weighted by the probability of being discovered in non-compliance. Thus, the expected penalty can be made higher (and hence more effective) by increasing either the actual penalty or the monitoring probability or both. Since monitoring is costly, it might appear that the best policy is to set the monitoring probability low, and the actual penalty high. However, the scope for increasing the penalty size is limited by the wealth of the polluter (for example, a firm is aware that it will only have to pay a fine as high as will send it bankrupt), and by the incentives created for penalty avoidance and evasion. Thus, the M&E policy must carefully balance the size of the actual penalty and the probability of enforcement.

A second key issue with respect to M&E policy design relates to use of *self-reporting*. Often much maligned by environmentalists, self-reporting can be a valuable arrow in the M&E policy quiver. The crucial element of a self-reporting policy is to set the penalty for

non-compliance relatively low, and the penalty of mis-reporting very high. This ensures that a firm in non-compliance has an incentive to report truthfully, which allows the implementation of an emergency clean-up response if warranted. Setting too high a penalty for non-compliance versus mis-reporting gives the firm an incentive to hide its non-compliance, especially for a one-time excessive discharge, which may lead to much more damage than if the discharge is reported quickly and cleaned up.

10.7 Trade, Competitiveness, and the Choice of Environmental Policy Instruments

We noted earlier that a key feature of economic instruments is their potential to be more cost-effective in implementing environmental quality goals than command-and-control polices. That feature of economic instruments becomes even more important when the policy problem is framed in a trade context. It is imperative for any country to achieve its environmental goals in a manner that is least damaging to its competitive position in relation to its trading partners. The costs associated with poorly chosen policy instruments in a closed economy can be magnified considerably in an open economy, since even small cost increases for domestic producers can mean the loss of significant economic rents for that country in the global market.[7]

Three other considerations also arise with respect to policy instrument choice in a trade context. First, trade rules may restrict the use of some types of instruments. For example, subsidies for pollution abatement or for cleaner technology adoption may be prohibited.

Second, the distribution of the cost burden for pollution abatement becomes an important consideration for competitiveness reasons. In particular, the “polluter pays principle”, which implicitly assigns environmental property rights to the state, and requires that polluters pay for damage to that property, may no longer be as appealing as it might otherwise be. Importantly, departing from the polluter pays principle does not necessarily

[7] See Chapter 8 for further discussion on this point.

require dropping the use of economic instruments. One approach to pricing emissions that does not put the burden of payment on the polluter is a tradeable emission permit scheme under which permits are initially granted free of charge (rather than through an auction). This has all the benefits of emissions pricing but implicitly assigns the right to pollute to the polluting firms.

Third, economic instruments, when applied in concert with the polluter pays principle, have the potential to raise government revenue that would otherwise have to be raised through more conventional taxes, such as income taxes and sales taxes. Such taxes, especially taxes on labor and savings, are distortionary and have associated welfare costs. The use of "green taxes" on pollution can potentially reduce the need to rely on distortionary taxes (and so have an associated "double dividend").[8] While the cost to firms of green taxes is often more visible than the costs associated with income taxes and other conventional taxes, they are not necessarily more detrimental to the competitiveness of those firms.

10.8 Synopsis

- The policy problem is to implement a resource allocation target as a corrected market equilibrium through the application of policy instruments to affect the incentives of economic agents.
- The resource allocation target should comprise an efficiency element and a distributional element. Sustainable development is such a target.
- Implementation of the policy target is a two tier problem, comprising the choice of regulatory regime, and the choice of instrument values.
- The optimal regulatory regime will generally comprise a mix of command-and-control regulation, economic instruments and other policy instruments.
- There are two main types of command-and-control regulation: performance standards; and design standards.

[8] See Chapter 11 (section 11.4) for further discussion on this point.

- Among the different types of performance standards, emission standards are generally the best instrument because they provide maximum flexibility to the regulated firm.
- Design standards impose requirements on abatement equipment and production technology. The adoption of a cleaner technology is not necessarily always optimal; adoption should be based on sound cost-benefit analysis.
- Command-and-control standards have two main drawbacks: they are generally not cost-effective; and they generally do not create correct incentives for on-going abatement.
- Economic instruments overcome both of these drawbacks by assigning an explicit price to pollution.
- The main economic instrument types are: emissions fees; emissions trading; and deposit-refund schemes.
- Other potentially powerful policy instruments include legal liability and information disclosure.
- The main impediments to the application of environmental policy instruments are political obstacles, and monitoring and enforcement costs. There is an important role for self-reporting in monitoring and enforcement policy design.
- The choice of environmental policy instruments should take careful account of the likely impact on the competitiveness of the regulated firms. Economic instruments are particularly appealing from that perspective.

10.9 Related Reading

Bohm, Peter and Clifford S. Russell (1997), "Comparative Analysis of Alternative Policy Instruments", in Peter Bohm, *The Economics of Environmental Protection*, Edward Elgar Press, Cheltenham, U.K.

O'Conner, David (1996), *Applying Economic Instruments in Developing Countries: From Theory to Implementation*, OECD Development Centre, Paris.

Roht-Arriaza, Naomi (1997), "Environmental Management Systems and Environmental Protection: Can ISO 14001 Be useful Within the Context of APEC?", *Journal of Environment & Development*, 6, 292-316.

11. Economy-Wide Policies and the Environment

11.1 Introduction

There are three key linkages between environmental polices and more general economy-wide policies. These are illustrated in Figure 11.1. First, economy-wide polices alter incentives, which affect the pattern of production and consumption flows within the economy, which in turn have associated environmental impacts. Second, economy-wide polices affect the structure of economic relationships within the economy, which in turn determine how economic agents will respond to specific environmental policies. For example, the impact of emission fees in an industry will depend on the competitive structure of that industry, which in turn reflects elements of the competition and industrial policies in place. Third, environmental policy can itself have resource allocation implications which are significant enough to warrant adjustment to other aspects of national policy. For example, the imposition of a carbon tax to address carbon dioxide emissions is likely to have a significant impact on production and consumption patterns, thereby requiring an adjustment to general economic and social policy.

This chapter reviews some of the key elements of each of these three relationships. We begin with the affect that economy-wide policies have on the pattern of production and consumption flows. We then examine how economy-wide policies can influence the structure of economic relationships, and how those relationships in turn affect the efficacy of environmental policy. We then discuss the feedback effect that environmental policy can have on economy-wide policies.

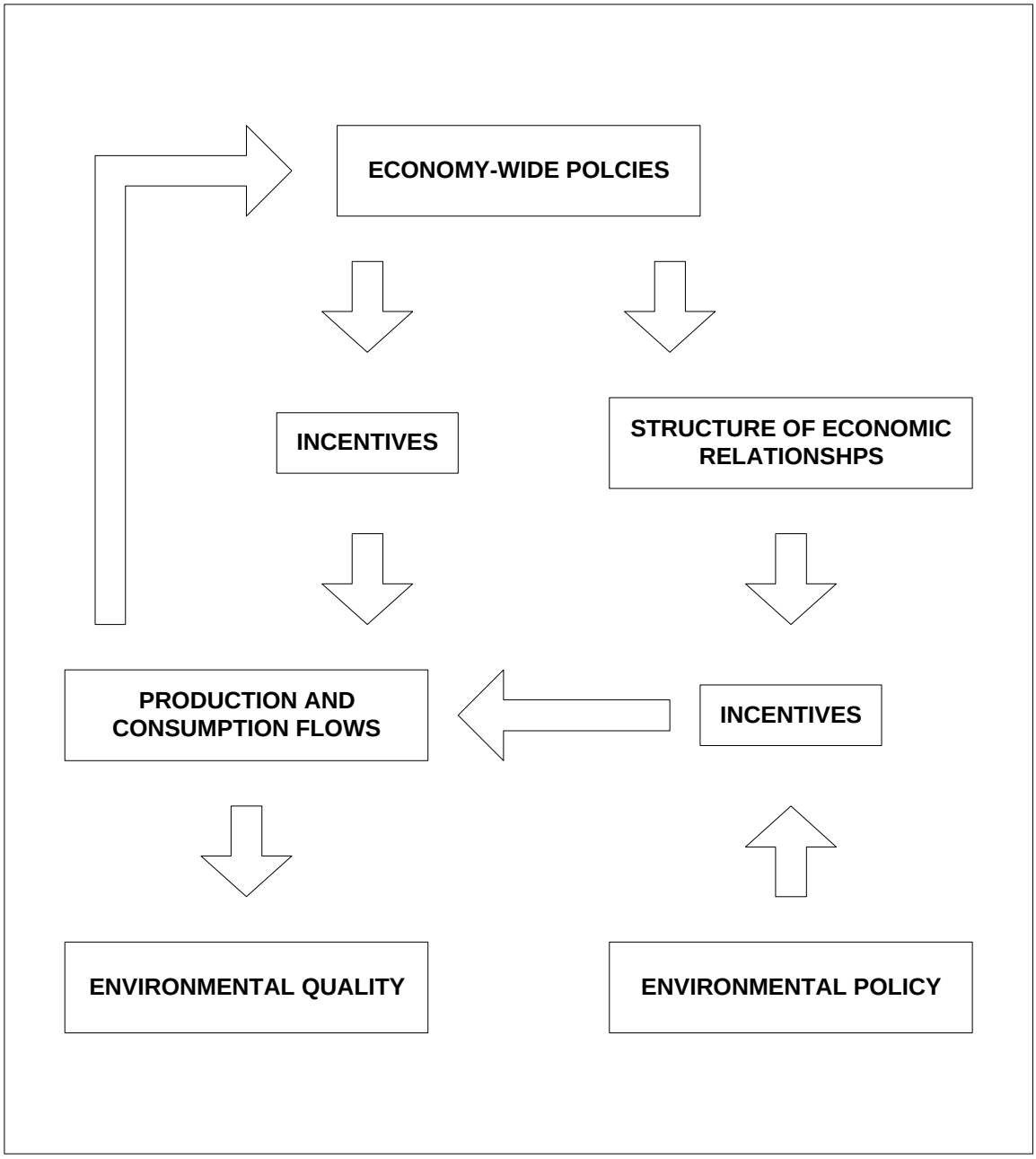

Figure 11.1

The Relationship Between Environmental Policy and Economy-Wide Policies

11.2 Economy-Wide Policies and the Pattern of Production and Consumption Flows

A wide variety of policies have indirect environmental impacts via their affect on production and consumption flows. This relationship between environmental policy and economy-wide policy is highlighted in Figure 11.2. We will confine discussion to some of the most important elements of that relationship.

Trade Policies

Trade liberalization and other trade-related polices can have significant impacts on production and consumption patterns, and consequently on environmental quality.[1]

Taxes and Subsidies

All governments use a variety of taxes and subsidies, for a wide variety of reasons. The purpose of many taxes and subsides is to redistribute wealth, but in doing so, they inevitably also distort behavior through their impact on incentives. Subsidies (or tax concessions) paid to certain industries or productive activities are a case-in-point. These policies encourage investment in those industries and activities, and lead to higher levels of production than would otherwise occur.

Education Policies

Basic education is the key to fostering the development of a strong knowledge-capital stock, which is in turn the key to long-term sustainable development. Policies that discourage education either directly or indirectly (for example, through the subsidization or protection of unskilled labour) can have serious long-term consequences for all aspects of an economy, including environmental quality.

[1] See Chapters 5 and 6 for a detailed discussion.

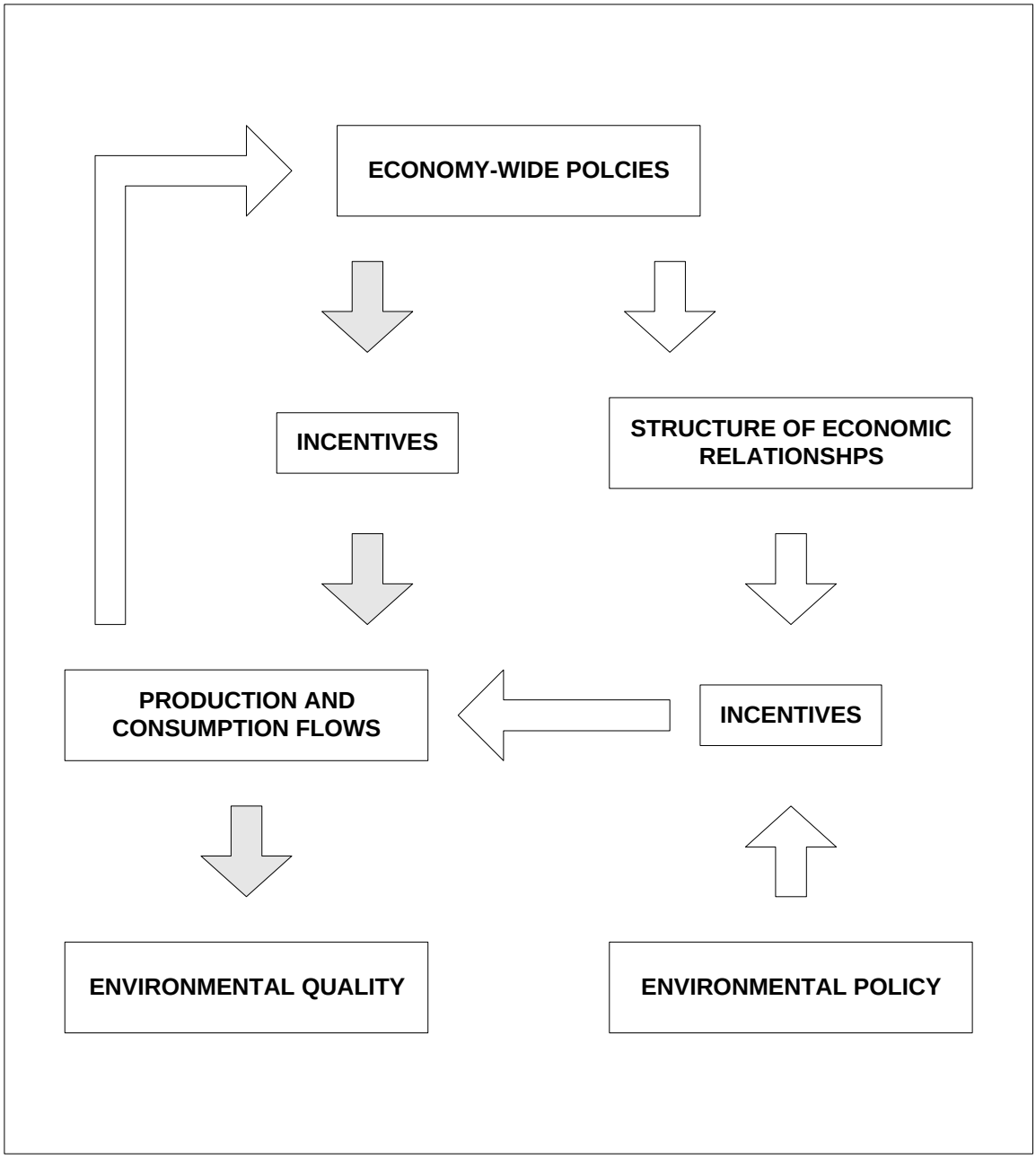

Figure 11.2

Economy-Wide Polices and the Pattern of Production and Consumption Flows

Policies that Affect Fertility Rates

The education of women can dramatically reduce fertility rates, which is one of the key determinants of sustainability. Other policies and programs, such as social security programs and the tax treatment of retirement savings, also have important implications for fertility and population growth rates.

The Distribution of Wealth

Environmental degradation is closely correlated with poverty. Policies that affect the distribution of wealth can therefore have important implications for environmental quality.

11.3 Economy-Wide Polices and the Structure of Economic Relationships

Environmental regulation implements policy targets by affecting incentives, and the incentive effects of any particular policy are a function of the prevailing structure of economic relationships. This structure is in turn a function of economy-wide policies. This link between economy-wide policy and environmental policy is highlighted in Figure 11.3. In this section we briefly review some of the most important aspects of that link.

Industrial Structure

The degree and nature of competition within an industry, as determined by competition policy and industrial policy, has a substantial impact on how the firms in that industry will respond to particular policy instruments. For example, the functioning of a tradeable emission permit scheme could be hampered by strategic interaction between firms associated with imperfect competition in their product market. Similarly, large dominant-employer firms are likely to have greater bargaining power than small firms in any industry-regulator negotiations over environmental standards.

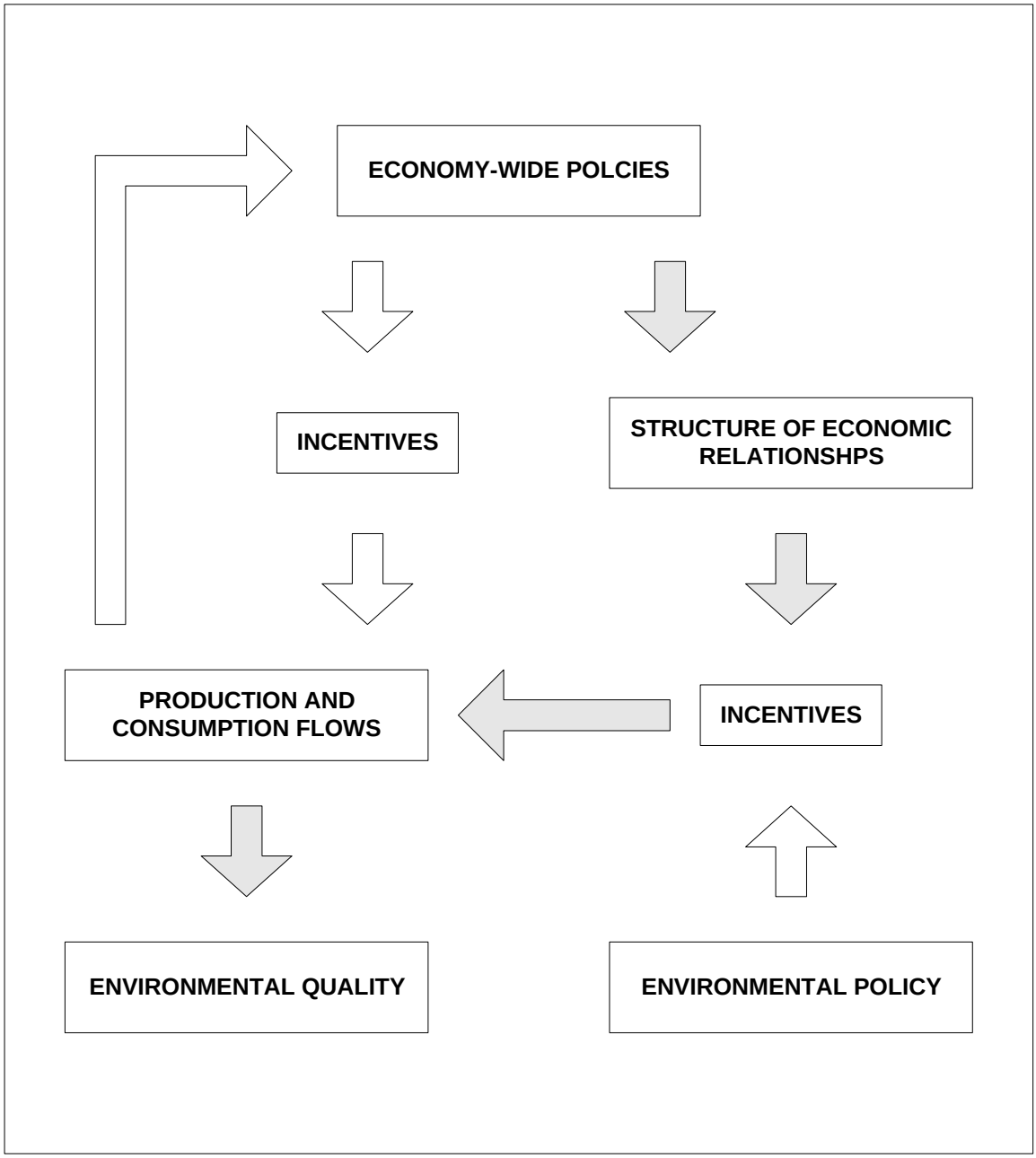

Figure 11.3

Economy-Wide Polices and the Nature of Economic Relationships

Privatization

The trend towards privatization in many economies is changing the nature of the relationship between regulators and regulated firms. In particular, political suasion may be a less effective policy instrument when dealing with private versus publicly-owned firms. More formal policy instruments may become increasingly necessary.

Inter-Governmental Relations

The political structure within a country can have a significant influence on the efficacy of environmental policy. For example, if the states within a federation have unilateral power with respect to setting environmental policy, then there arises the potential for strategic distortion of that policy, as can arise between countries competing for a share of economic rents.[2] Decentralization of political power within a federation can therefore have important implications for how environmental policy is set.

Labor Market and Capital Market Flexibility

The environmental impacts of economic restructuring in response to trade liberalization and technological change can be made worse if that restructuring does not occur smoothly, as individuals are displaced, and declining firms cut environmental corners in an attempt to survive. Smooth restructuring requires flexible labour and capital markets. This is not to say that labor and capital markets should be unregulated, but it does mean that regulation should not restrict the capacity for these markets to respond to changing circumstances.

Legal Structure

The efficacy of the legal structure in a country can play a major role in determining the efficacy of environmental policy. First and foremost, regulations must be enforceable, and this requires the existence of a strong and independent judiciary. Moreover, the legal rights and obligations of firms have an important affect on the relationship between firms and the regulator. For example, the emerging OECD-sponsored Multilateral Agreement

[2] See Chapters 8 and 9 for further discussion.

on Investment (MAI) is causing some concern among governments about the erosion of sovereign power. In particular, some governments are concerned about corporate rights to compensation for regulatory changes. Environmental regulation is an inherently dynamic process, responding to new information about damage and the availability of new technologies, and it is important that governments have the freedom to make required changes on an ongoing basis. However, agreements like the MAI, if properly designed, can help to ensure that regulatory changes are not used as a protectionist measure by discriminating against foreign-owned firms.

11.4 The Implications of Environmental Policy for Other Aspects of Economic Policy

The links between environmental policy and economy-wide policies discussed in sections 11.2 and 11.3 are of one direction: economy-wide policies affect the need for and the efficacy of environmental policy. However, there is an also important linkage in the other direction. This linkage is highlighted in Figure 11.4. Substantial environmental policy initiatives can cause economic structural changes of sufficient magnitude as to warrant the realignment of other economic polices. We will focus on two macroeconomic aspects of that relationship: taxation and debt.

Taxation

The so-called “double-dividend” associated with the imposition of green taxes (such as emission fees and auctioned emission permits) has captured a great deal of attention recently. The basic idea is the following. Green taxes will help to correct the inefficiency associated with unpriced environmental damage, and at the same time, the revenue collected from those taxes will allow for a reduction in conventional forms of distortionary taxation (such as those on labor and investment), with an associated additional welfare

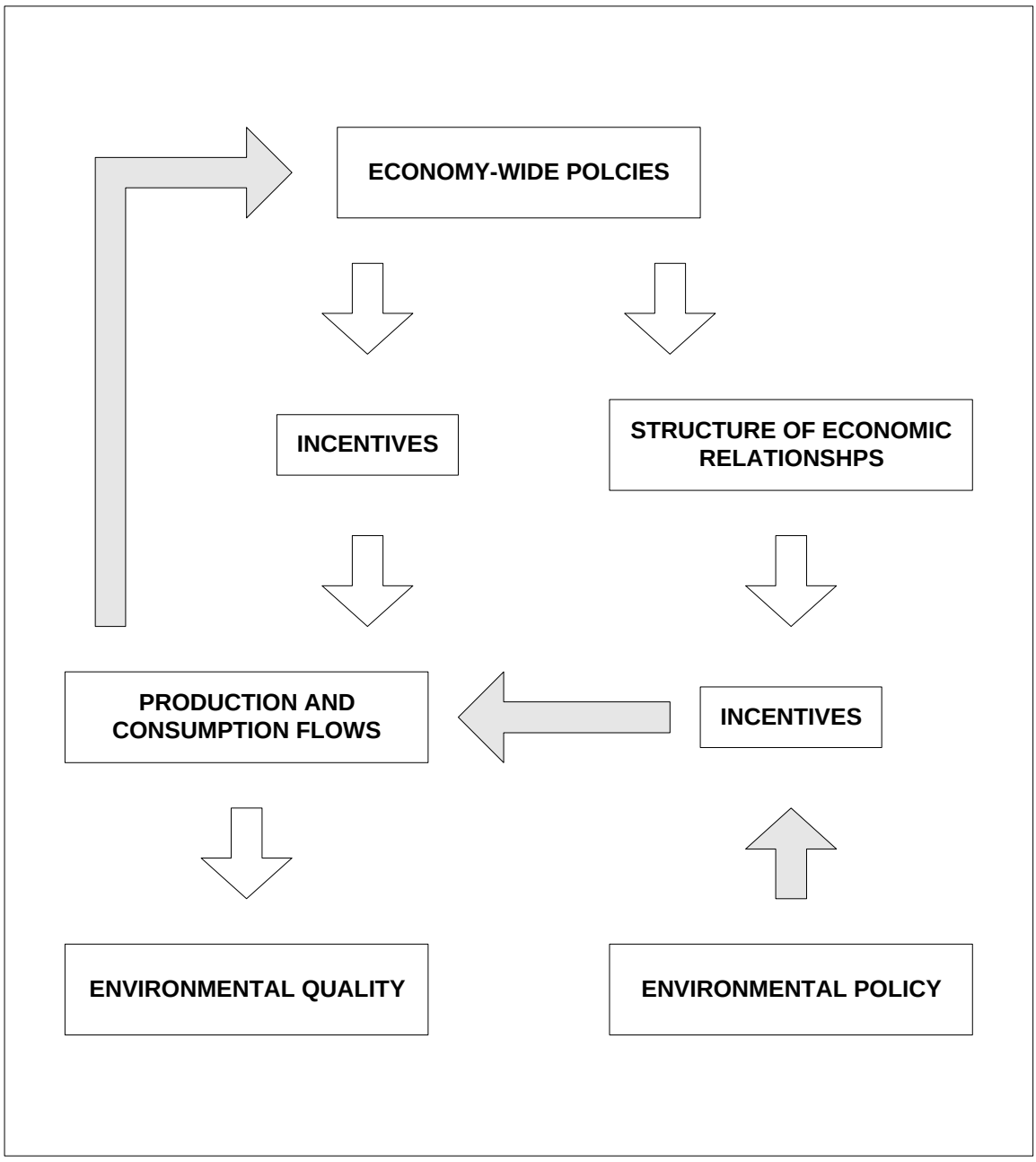

Figure 11.4

The Implications of Environmental Policy for Other Aspects of Economic Policy

gain. For this reason, the substitution of green taxes for distortionary taxes on wealth-creating activity has much to recommend it, though it must be stressed that the primary purpose of green taxes should be to correct incentives with respect to the allocation of environmental resources, not to raise revenue *per se*.

On the other side of the taxation coin is the potential for substantial broad-based green taxes to precipitate significant structural changes in the economy, which will need to be managed.[3] The most important example of such a tax measure is a carbon tax, the imposition of which would affect all sectors of an economy in possibly dramatic ways, depending on the magnitude of the tax.

Debt

Government debt is an increasingly unpopular institution. Nonetheless, debt can play an important role in managing large economic adjustments that have significant intergenerational welfare impacts. For example, large-scale changes in current production and consumption patterns for the purpose of environmental protection are likely to impose significant costs on current generation individuals, while the principal beneficiaries of those structural changes will be future generations. Debt can serve as a useful mechanism to spread the costs and benefits more evenly.

Of course, many people would argue that the burden of adjustment *should* fall on current generations since they have no right to borrow on the natural capital of future generations. However, to some extent, ethical debates of this type are beside the point. From a pragmatic perspective, it may well be that the only way to induce the current generation to change their behavior for the benefit of future generations is if they are able to off-load some of the associated costs to those future generations. If sustainable development is to be attained, it must be more than an ethically compelling notion; it must also be politically implementable. The judicious use of debt, especially to finance

[3] See Chapter 6 for a discussion of principles for the management of structural adjustment.

investment in cleaner technologies, can potentially be an important element of that implementation.

11.5 Synopsis

- There are three key linkages between environmental policies and more general economy-wide policies:
    - ◊ economy-wide policies affect the patterns of production and consumption, which in turn have environmental impacts;
    - ◊ economy-wide policies affect the structure of economic relationships, which in turn determine how economic agents will respond to environmental policies; and
    - ◊ environmental policy can have an impact of a magnitude sufficient to warrant the adjustment of economy-wide policies.
- Among the key elements of the first linkage are:
    - ◊ trade policies;
    - ◊ taxes and subsidies;
    - ◊ education policies;
    - ◊ policies that affect fertility rates; and
    - ◊ the distribution of wealth.
- Among the key elements of the second linkage are:
    - ◊ industrial structure;
    - ◊ privatization;
    - ◊ inter-governmental relations;
    - ◊ labor market and capital market flexibility; and
    - ◊ legal structure.
- Among the key elements of the third linkage are:
    - ◊ taxation policy; and
    - ◊ debt policy.

11.6 Related Reading

Porter, Gareth (1997), "Natural Resource Subsidies and International Policy: A Role for APEC", *Journal of Environment & Development*, 6, 276-291.