An Analysis and Case Study of the Role of Environmental Economics at the Asian Development Bank

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Foreword

The ERD Technical Note Series deals with conceptual, analytical, or methodological issues relating to project/program economic analysis or statistical analysis. Papers in the Series are meant to enhance analytical rigor and quality in project/program preparation and economic evaluation, and improve statistical data and development indicators. ERD Technical Notes are prepared mainly, but not exclusively, by staff of the Economics and Research Department, their consultants, or resource persons primarily for internal use, but may be made available to interested external parties.
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Abstract

Acid rain falls on 30 percent of arable land in the People's Republic of China (PRC), according to official estimates. The resulting environmental damage is acute in parts of the Yangtze River Valley, such as Anhui Province in central PRC. Severe environmental degradation is common not only in the PRC, but also across the Asian and Pacific region.

In 2001, the Asian Development Bank (ADB) approved a loan to finance a project in Anhui Province that would promote cleaner production, improve energy efficiency, and reduce waste. The Project is expected to reduce the frequency of acid rain by half, and reduce emissions of greenhouse gases by 476,800 tons per year. The economic analysis is based strictly on improving the efficiency of manufacturing processes. The estimated economic internal rate of return on the components of the project ranges from 14 to 28 percent, but the economic analysis, surprisingly, did not include monetized environmental benefits. This paper uses the acid rain control project to illustrate the role of ADB in environmental protection in the Asian and Pacific region. The paper also uses the Project to illustrate the role of environmental economics in the economic analysis of projects at ADB, and to suggest ways to better integrate environmental economics into both development planning and the analytical process.
I. Introduction

According to the *Asian Environmental Outlook 2001*, “environmental degradation in (Asia and the Pacific) is pervasive, accelerating, and unabated. At risk are people’s health and livelihoods, the survival of species, and ecosystem services that are the basis for long-term economic development” (ADB 2001a). The environmental degradation occurring in the Asian and Pacific region is not contained within the region, though: the region also contributes significantly to the potential for global climate change, through deforestation and emissions of greenhouse gases.

Living amidst the growing environmental degradation in Asia and the Pacific are 900 million of the world’s poor, approximately a third of the region’s population. Reducing poverty is an equal or even higher priority (at the Asian Development Bank [ADB]) than improving environmental quality, so improving environmental quality must accommodate strong economic growth.

ADB is actively engaged in promoting both poverty reduction and environmental protection in the Asian and Pacific region. ADB’s “overarching objective” is poverty reduction, and one way that ADB seeks to reduce poverty is through environmentally sustainable development. Since 1995, ADB has been involved in more than 170 projects related to environmental protection and economic development in Asia, involving funds in the hundreds of millions of dollars (ADB 2002b).

Economic analysis of projects is an important part of ADB’s operations, and so environmental economics has the potential to directly contribute directly to ADB’s activities in environmental protection. For example, whenever benefit-cost analysis is applicable, ADB requires that any environmental benefits and costs be expressed in monetary terms, to the extent possible and practicable. Ideally, the information provided by a benefit-cost analysis should influence the design of a project, so environmental economics can contribute to both the design and analysis of a development project.

The design and analysis of projects, though, is constrained by ADB’s policies and operating procedures. ADB’s operations are governed by the social goals of its shareholders, as revealed and defined in various official statements of policy and purpose. These official statements, reviewed in the first section below, determine both broad and specific guidelines for ADB’s operations. The guidelines orient the application of environmental economics (particularly benefit measurement) to welfare improvements that focus on a single country, and that are directly associated with the household income and expenses of the poor. The most applicable research methods use local information (possibly from household surveys), and are easy and inexpensive to apply. In its main operations, ADB has limited potential for involvement in projects directly or exclusively related to global change, until markets for carbon credits are firmly established.
One example of ADB’s environmental efforts is the Acid Rain Control and Environmental Improvement Project in People's Republic of China (PRC), which ADB is helping to finance through a US$147 million loan. The economic analysis of this project, reviewed in the second section below, established a strong economic basis for the project based only on the direct benefits to the industrial enterprises involved in the project. The environmental and economic problems addressed by this project are so severe that only relatively simple methods are needed to establish the economic basis for the project.

ADB will be involved in similar projects in the near future, as discussed in the final section of the paper, so environmental economics will continue to have a role at ADB. The environmental and economic problems are not always as severe as in the Acid Rain Control Project, and so the analysis is not always as simple and obvious. But ADB’s various goals, guidelines, and procedures will continue to orient economic analysis toward methods that are simple and easy to apply. Economic analysis is almost always constrained by the quantity and quality of data. So further research in environmental economics can help ADB promote environmental protection in Asia by focusing on methods to collect and analyze relatively small amounts of data.

II. Environmental Projects and Environmental Economics at ADB

ADB is a multilateral development finance institution dedicated to reducing poverty in the Asian and Pacific region. ADB’s main business is to loan foreign currency to its developing member countries. In 2001, for example, ADB approved 76 loans totaling US$5.34 billion. ADB usually provides a grant to help a country prepare a loan proposal. In 2001, ADB provided 64 such grants, totaling US$40.4 million (ADB 2002a).

ADB’s shareholders are the governments of 61 countries, from both within and outside of Asia. Japan and the United States are the largest shareholders, each holding 13 percent of the votes on the Board of Directors. Some of ADB’s lending is funded by grants from the shareholders to ADB. Most of ADB’s funds, though, come from the sale of bonds on international capital markets. Loans from ADB carry an interest rate equal to the financial cost of ADB’s funds (0 percent in the case of loans from the Asian Development Fund) plus a margin (fixed across all loans) sufficient to cover ADB’s average operating costs.

As a nonprofit institution, ADB does not offer a financial return to its shareholders. Instead, ADB offers its shareholders the opportunity to promote and influence economic development in the less developed countries of Asia. Hence, ADB is governed not by profit-maximization, but by the social goals of its shareholders.

These social goals are manifested in ADB’s official strategies, policies, and other statements of purpose, and they determine the kinds of projects that ADB will help fund. ADB operates under at least 50 different statements of purpose (there are 50 titles under “Policies and Strategies” on ADB’s website, http://www.adb.org). These statements of purpose establish broad goals or frameworks, with their specific implementation spelled out in ADB’s Operations Manual.
ADB's primary statement of purpose is its *Poverty Reduction Strategy*, which establishes that ADB’s overarching objective is to reduce the incidence of poverty in the Asian and Pacific region (ADB 1999a). ADB pursues this objective by requiring that all projects it finances “contribute” to the reduction of poverty, with at least 40 percent of its lending devoted to poverty “interventions.”

ADB recognizes the importance of other social goals, but all other goals are subordinate to poverty reduction. For example, ADB aims to “reduce poverty through environmentally sustainable development”; ADB pursues this goal by, among other things, helping to finance projects with “environment as a thematic priority”, focusing on natural resource management, pollution control, and managing natural hazards (ADB 2002b).

The social goals of ADB’s shareholders also form and guide the bank’s internal operations. ADB pursues poverty reduction through several “core strategic areas”, including the promotion of “good governance” and “sustainable economic growth” (ADB 2001b). Public participation is one aspect of good governance that ADB has specifically identified, and is a common feature of many of ADB’s statements of purpose. The goal of promoting public participation affects ADB’s internal operations in a variety of ways, such as through the requirement that project development include direct consultation with the people that a project affects directly (ADB 1999b).

Economic analysis of projects is an important component of ADB’s internal operations. Although the requirement for economic analysis appears in ADB’s *Operations Manual* (ADB 1997b), none of ADB’s statements of purpose specifically calls for economic analysis, so economic analysis is not clearly tied to any of ADB’s stated social goals. Promoting economic growth has long been an important goal of ADB, though, so the requirement for economic analysis presumably derives from that goal (ADB 1966).

Economic analysis at ADB is governed only by general guidelines, rather than specific requirements. ADB’s guidelines are largely based on the economic theory of project analysis that was developed and applied in the 1970s in other multinational development institutions (UNIDO 1972, Gittinger 1972, Little and Mirrlees 1974, Squire and van der Tak 1975, Mishan 1976, ADB 1997a, Curry and Weiss 2000). The most specific guideline, and the one that tends to receive the most attention at ADB, is that “the basic criteria for a project’s acceptability” is an economic internal rate of return of 12 percent. A return as low as 10 percent is acceptable for projects where “additional unvalued benefits can be demonstrated, and where they are expected to exceed unvalued costs” (ADB 1997a).

A salient feature of ADB’s application of the theory of project analysis, at least as regards environmental economics, is the exclusive focus on the economic benefits and costs within the country that hosts the project. Project analysis at ADB aims, in general, to “assess the overall impact of a project on improving the economic welfare of the citizens of the country concerned” (ADB 1997a, 9). The impact on economic welfare is measured by estimating net present value of the increase in a country’s net national product. Net national product, as it is applied at ADB, includes environmental costs and benefits (as well as other nonmarket impacts), but only those benefits and costs that occur within the political borders of the country. In particular, ADB’s economic guidelines advocate using international prices as estimates...
of the value of a project’s inputs and outputs, regardless of whether those prices reflect full social or environmental costs in other countries (ADB 1997a).

Of course ADB could apply the theory of project analysis at an international level, but such an analysis could end up supporting projects that would conflict with ADB’s objectives. For example, a project focusing on global climate change could have positive net present value at a global scale, but negative net present value within the country hosting the project. Such a project would amount to a net transfer of wealth from a poor Asian country, and so such a project would be difficult to reconcile with ADB’s primary objective of poverty reduction, and various other secondary objectives.

The focus on a single country, however, seems to conflict with some of ADB’s official statements of purpose and practice. For example, ADB’s forthcoming Environment Policy calls for ADB to help “maintain global life support systems and address regional transboundary environmental issues”, and integrate “environmental considerations into ADB operations” (ADB 2002b). ADB’s Operations Manual requires that “environmental costs and benefits are included as far as possible” (ADB 1997c). One could interpret these statements as requiring that all environmental benefits and costs be included in an economic analysis, regardless of where they occur.

The apparent conflicts, however, affect only economic analysis. ADB’s statements of purpose make it clear that regional and global environmental issues have high priority at ADB. ADB aims to address regional and global environmental issues not through loans for specific projects, but through (i) promoting intergovernmental cooperation, (ii) participating in international environmental agreements, (iii) facilitating technology transfer, (iv) capacity building for policymakers, and (v) support for regional environment programs and institutions (ADB 2002).

ADB’s guidelines for economic analysis make it clear that the main focus of economic analysis is the country hosting the project, but ADB has not officially resolved the potential conflicts that its statements of purpose and practice create for the economic analysis of environmental projects. An unofficial and informal consensus has, however, developed within the institution. Whenever a project has impacts outside a country’s borders, the accepted practice within ADB is to conduct two analyses, one focusing on the country, and another including all benefits and costs regardless of where they occur. The country-focused analysis provides the primary economic basis for a project, and is subject to the minimum 12 percent rate of return. ADB has not established a standard for the unrestricted or global analysis, mainly because no project has yet forced ADB to address the issue. It’s unlikely, though, that ADB would support a project that had significant negative net benefits outside the given country, regardless of the rate of return to that country. Since the country-focused analysis provides the primary economic basis for a project, there is often little incentive to conduct an unrestricted analysis. Therefore, the unrestricted analysis is not usually conducted, even though it would seem to be required under ADB’s own policies and guidelines.

The country-focused analysis can include environmental benefits outside the given country, provided those benefits are tied to an economic return to the given country. For example, the analysis of a project to mitigate global climate change could include the value of
the global environmental impacts that accrue to the given country. For example, global benefits might be allocated to a country on the basis of its population or land area. The country-focused analysis could also include impacts outside the country, if those impacts were tied directly to economic returns for the given country—for example, the receipt of funds from the Global Environment Facility. In this case, positive environmental impacts outside the country are treated in the same way as an export.

The combined effect of ADB's various social goals puts severe constraints on the kinds of environment projects that ADB will help fund, and the kind of economic analysis that can be applied. If a project must have a rate of return of 12 percent or higher, and if the return cannot include global benefits, then the project will have to focus largely on the environment of the country where the project is based. ADB's objectives tend to steer it away from projects with major adverse impacts, and so the role for environmental economics is mainly to monetize beneficial environmental impacts. If all ADB projects must “contribute to poverty reduction”, then environment projects must focus on direct and tangible benefits to the standard of living of the poor. This largely excludes projects focusing on nonuse benefits (option value, intrinsic value, and the like), and thereby excludes a major application of contingent valuation and other nonmarket valuation methods. If all projects must involve direct consultation with stakeholders, then the benefits transfer method is, in principle, limited only to recently conducted studies in the same area as the project. In practice, though, benefits transfer may be applied where benefits that are established through other means provide a sufficient economic basis for the project (ADB 1996).

Limited time and other resources also constrain economic analysis, and so the economic analysis tends to produce the minimum analysis that meets requirements. ADB’s guidelines for economic analysis require only a minimum rate of return, and do not require that all benefits be monetized. The only incentive for exceeding the minimum return is to establish the margin of error for the return above the minimum. Hence, economic analysis of environmental impacts tends to focus on large beneficial impacts that can be easily and clearly established, leaving unquantified the monetary values of many minor impacts.

III. Economic Analysis of the Acid Rain Control Project

The Acid Rain Control Project is an excellent example of ADB’s role in environmental protection in Asia, and the role of environmental economics in project analysis at ADB. ADB regarded the Project as reducing poverty through environmentally sustainable development, one of the institution’s three “crosscutting themes”. That is, although the Project will not directly increase incomes of the poor, the Project will substantially increase the quality of life of the poor (and all residents of Anhui Province), through improved environmental quality and improved prospects for sustainable economic growth.

Acid rain is a serious environmental and economic problem in the PRC. According to official estimates, acid rain falls on 30 percent of arable land in the PRC. Annual economic costs from all forms of air pollution have been estimated at about six percent of gross domes-
tic product (GDP), with annual economic costs from acid rain at about two percent of GDP. The emissions that produce acid rain are based in urban areas, and so also cause serious urban air pollution.

Acid rain and other environmental problems are especially acute in the part of the Yangtze River Valley that lies in Anhui Province. The province has experienced rapid economic growth and industrial development over the last two decades. Industrial development has generated high levels of industrial emissions, and economic growth has enabled increasing use of motor vehicles, with their attendant emissions.

Private (or to be privatized) enterprises are the main source of the emissions that cause acid rain in the PRC. The main cause of acid rain is sulfur dioxide from the burning of coal. About 40 percent of total sulfur dioxide emissions come from industrial sources, with another 40 percent from power generation, and 20 percent from residential and commercial sources.

The Project includes several different components. The components discussed here aim to install cleaner production technologies at six industrial enterprises in three cities of Anhui Province. The six enterprises are:

(i) Anhui Tongdu Copper Limited Company
(ii) Chizhou Non-Ferrous Metals Group Company
(iii) Wuhu Feiying Wood Chemicals Limited Company
(iv) Wuhu Hengchang Copper Refinery Company
(v) Wuhu Shanjiang Chemicals Limited Company
(vi) Wuhu Zhengxing Materials Limited Company

The first enterprise is in the city of Tongling, the second is in the city of Chizhou, and the rest are in Wuhu. (Henceforth, “the Project” will refer to these six components, although the whole Project does include several other important components.)

Without the Project, the enterprises may invest in changing their production processes on their own. The enterprises are using old and inefficient technologies, and as market forces continue to increase in the PRC, it is plausible that the enterprises would eventually recognize the investment opportunities on their own. Without the Project, though, the enterprises would face difficulties in obtaining funding from private sources, resulting in perhaps long delays in undertaking the investments. More important, though, is that there are insufficient mechanisms compelling the enterprises to internalize the net social benefits of clean technologies. Absent such mechanisms, the net private benefits of clean technologies are likely to be lower than that of other technologies, and so the enterprises would likely make different (and less socially beneficial) investments than those made under the Project.

The lack of incentive in the firms needs to be classified. The analysis in the next section indicates that enterprises benefit from better technology. They are rewarded with financial benefits through energy savings, waste reduction, waste conservation, and higher-quality output. It needs to be pointed out that despite this fact, firms will still not opt to install the cleaner technology due to:

(i) their difficulty in getting access to financing;
(ii) the cost of investing in cleaner and better technology is higher than benefit to be gained from making this investment; and
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(iii) there are insufficient mechanisms in terms of regulations, and monitoring and enforcement measures to push firms to internalize the environmental cost.

The rationale for government intervention is therefore based on the absence of environmental benefits and costs in the private decision making of the enterprises. The Project addresses this market failure by, in a sense, acquiring an important but minor and temporary role in the decision making process. Under the Project, ADB will loan funds to the government of Anhui Province, who will itself then loan funds to the six enterprises, under the same terms as the government's loan from ADB. The enterprises will repay their loans to the government, so the Project is not (directly) subsidizing the enterprises. The loan is at terms much more favorable than the enterprises could get from private sources (that is the only sense in which there is a “subsidy”), but the enterprises are otherwise bearing all costs incurred under their involvement in the Project. The favorable terms of the loan give the enterprises strong incentives to borrow from the government, but the terms of the loan stipulate the specific investments the enterprises will make. The Project is therefore influencing the enterprises to make investments that are in the public interest, but the investments are also freely made and in the private interests of the enterprises.

Development of the Project was supported with a grant of US$964,000 from ADB. The grant supported a team of eight consultants, including four engineers, two financial specialists, and two economists. The team of consultants worked for 10 months evaluating the technical, financial, social, and economic aspects of the problem of acid rain, and the proposed solutions. The following economic analysis derives from the report submitted by the team of consultants (Ecology and Environment 2001).

The base assumptions of the economic analysis are as follows. All monetary values are expressed in constant prices, as of 2000, with the domestic currency (yuan) as the numeraire. The Project's horizon is taken as 20 years, with no residual value beyond the last year. Some of the Project's inputs and outputs are traded on international markets, and so their opportunity costs were estimated using international prices. Following standard practice in project analysis, prices in foreign currency were converted to the domestic currency using an exchange rate 11 percent higher than the market rate (ADB uses 1.11 as the shadow exchange rate factor for the PRC). For inputs and outputs that are not traded on international markets, the opportunity costs were calculated either from market prices, excluding all transfer payments, or by direct calculation of the opportunity cost (for example, the long-run marginal cost of electricity).

The costs of the Project are limited to the capital costs and the operations and maintenance (O&M) costs of the new production processes. Relative to the without-project scenario, the Project has virtually no adverse environmental impact on any resource, so there are no gross environmental costs to be accounted for. The capital and O&M costs are calculated as the increment relative to the without-project scenario.

The Project was designed to generate many benefits, both to the private enterprises and to the public as a whole. Benefits to the enterprises include energy savings, waste reduction, waste conversion, and higher quality output. Waste reduction includes lower emissions of wastewater, and waste conversion includes capturing sulfur dioxide and converting it into marketable sulfuric acid. Benefits to the public as a whole include improved urban air quality,
improved water quality, and reduced frequency of acid rain. Improved urban air quality results not only from lower emissions of sulfur dioxide, but also from relocating the enterprises out of residential areas, thereby reducing exposure to emissions. The energy savings will also reduce emissions of carbon dioxide, and so may mitigate global climate change relative to the without-project scenario. Table 1 briefly describes the main environmental impacts.

Although the Project will produce many positive environmental impacts, the monetary values of the Project’s benefits are limited to the private benefits of the enterprises. The value of energy savings was estimated in terms of the cost of the coal that would be required to generate that amount of energy. The value of waste reduction was estimated using the cost of disposing of that waste. The value of waste conversion was estimated as the gross profit from sales of the sulfuric acid (revenue less production cost), plus the cost of disposing of that waste in the without-project scenario. The value of higher quality output was estimated as the incremental revenue generated under the Project.

Table 1. Reduction in Emissions (tons/year) Compared to a No-ADB Project Scenario

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>Sulfur Dioxide</th>
<th>Carbon Dioxide</th>
<th>Total Soluble Phosphates</th>
<th>Nitrites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongdu Copper</td>
<td>14890</td>
<td>92928</td>
<td>1604</td>
<td>336</td>
</tr>
<tr>
<td>Non-Ferrous Metals</td>
<td>6040</td>
<td>40747</td>
<td>328</td>
<td>147</td>
</tr>
<tr>
<td>Feiying Wood Chemicals</td>
<td>1372</td>
<td>109463</td>
<td>592</td>
<td>396</td>
</tr>
<tr>
<td>Hengchang Copper</td>
<td>1952</td>
<td>15368</td>
<td>858</td>
<td>56</td>
</tr>
<tr>
<td>Shanjiang Chemicals</td>
<td>4533</td>
<td>40480</td>
<td>328</td>
<td>146</td>
</tr>
<tr>
<td>Zhengxing Materials</td>
<td>2545</td>
<td>177819</td>
<td>1240</td>
<td>643</td>
</tr>
</tbody>
</table>

Note: There are other beneficial impacts not shown in the table.

The Project has a very strong economic basis, even though the monetary values of the many environmental impacts are not included. The economic internal rate of return for the six enterprises varies from 14 to 27 percent. A thorough risk analysis was also conducted, using Monte Carlo simulation of all significant uncertainties in the benefits and costs. The risk analysis showed virtually no chance of the rate of return of the Project falling below 12 percent. Tables 2 to 7 show the monetized benefits and costs of the Project.

The Project and its economic analysis closely fit the kinds of projects and analyses at ADB, as described in the previous section. The Project (not to mention the economic analysis) focuses largely on environmental benefits to the PRC, and does not specifically aim to improve the regional or global environment. Nonetheless, the Project will contribute to mitigating global climate change, through increased energy efficiency requiring less burning of coal, resulting in lower emissions of carbon dioxide. The benefits to the global environment, however, were not included in the main economic analysis, in accordance with ADB’s internal guidelines.
### Table 2. *Tongdu Copper (Y’000)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost</th>
<th>O&amp;M Cost</th>
<th>Incremental Costs</th>
<th>Incremental Benefits</th>
<th>Other Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>(112,748)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(112,748)</td>
</tr>
<tr>
<td>2003</td>
<td>(207,706)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(207,706)</td>
</tr>
<tr>
<td>2004</td>
<td>(75,706)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(77,321)</td>
</tr>
<tr>
<td>2005</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(84,045)</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>(8,339)</td>
<td>0</td>
<td>0</td>
<td>24,327</td>
</tr>
<tr>
<td>2007</td>
<td>0</td>
<td>(55,273)</td>
<td>92,640</td>
<td>(16,303)</td>
<td>54,871</td>
</tr>
<tr>
<td>2008</td>
<td>0</td>
<td>(198,720)</td>
<td>240,864</td>
<td>(4,245)</td>
<td>92,005</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>(301,205)</td>
<td>314,984</td>
<td>67,141</td>
<td>119,061</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td>(275,306)</td>
<td>314,984</td>
<td>68,298</td>
<td>120,220</td>
</tr>
<tr>
<td>2015</td>
<td>0</td>
<td>(275,316)</td>
<td>314,984</td>
<td>68,298</td>
<td>120,221</td>
</tr>
<tr>
<td>2020</td>
<td>0</td>
<td>(275,315)</td>
<td>314,984</td>
<td>68,298</td>
<td>120,221</td>
</tr>
<tr>
<td>2021</td>
<td>0</td>
<td>(275,315)</td>
<td>314,984</td>
<td>69,467</td>
<td>120,221</td>
</tr>
<tr>
<td>2022</td>
<td>53,147</td>
<td>(207,361)</td>
<td>314,984</td>
<td>69,467</td>
<td>217,651</td>
</tr>
</tbody>
</table>

NPV @ 12% 69,228  
EIRR 14.3%

### Table 3. *Non-Ferrous Metals (Y’000)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost</th>
<th>O&amp;M Cost</th>
<th>Incremental Costs</th>
<th>Incremental Benefits</th>
<th>Other Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>(12,935)</td>
<td>(2,443)</td>
<td>3,582</td>
<td>0</td>
<td>(11,456)</td>
</tr>
<tr>
<td>2003</td>
<td>(28,279)</td>
<td>(1,080)</td>
<td>3,582</td>
<td>0</td>
<td>(25,777)</td>
</tr>
<tr>
<td>2004</td>
<td>(67,256)</td>
<td>(734)</td>
<td>3,582</td>
<td>0</td>
<td>(64,408)</td>
</tr>
<tr>
<td>2005</td>
<td>(27,852)</td>
<td>(7,391)</td>
<td>8,730</td>
<td>28,664</td>
<td>(23,659)</td>
</tr>
<tr>
<td>2006</td>
<td>(132,663)</td>
<td>(7,391)</td>
<td>69,564</td>
<td>75,050</td>
<td>11,951</td>
</tr>
<tr>
<td>2007</td>
<td>(153,848)</td>
<td></td>
<td>106,688</td>
<td>81,870</td>
<td>34,710</td>
</tr>
<tr>
<td>2008</td>
<td>(170,634)</td>
<td></td>
<td>125,250</td>
<td>81,990</td>
<td>36,596</td>
</tr>
<tr>
<td>2009</td>
<td>(165,644)</td>
<td></td>
<td>125,250</td>
<td>86,770</td>
<td>46,474</td>
</tr>
<tr>
<td>2010</td>
<td>(165,640)</td>
<td></td>
<td>125,250</td>
<td>86,770</td>
<td>46,474</td>
</tr>
<tr>
<td>2015</td>
<td>(165,632)</td>
<td></td>
<td>125,250</td>
<td>86,770</td>
<td>46,474</td>
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<tr>
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<td></td>
<td>125,250</td>
<td>86,770</td>
<td>46,474</td>
</tr>
<tr>
<td>2021</td>
<td>(165,632)</td>
<td></td>
<td>125,250</td>
<td>86,770</td>
<td>46,474</td>
</tr>
<tr>
<td>2022</td>
<td>12,317</td>
<td>(124,823)</td>
<td>125,250</td>
<td>86,770</td>
<td>106,691</td>
</tr>
</tbody>
</table>

NPV @ 12% 87,950  
EIRR 22.4%
Table 4. Feiying Wood Chemicals (Y’000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost</th>
<th>O&amp;M Cost</th>
<th>Output</th>
<th>Energy Saving</th>
<th>Incremental Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>(23,121)</td>
<td>(715)</td>
<td>0</td>
<td>0</td>
<td>(23,836)</td>
</tr>
<tr>
<td>2003</td>
<td>(62,805)</td>
<td>(1,906)</td>
<td>0</td>
<td>0</td>
<td>(64,711)</td>
</tr>
<tr>
<td>2004</td>
<td>(99,826)</td>
<td>(110)</td>
<td>0</td>
<td>0</td>
<td>(99,936)</td>
</tr>
<tr>
<td>2005</td>
<td>(69,140)</td>
<td>(76,196)</td>
<td>97,073</td>
<td>7,680</td>
<td>(40,582)</td>
</tr>
<tr>
<td>2006</td>
<td>(71,666)</td>
<td>110,941</td>
<td>8,777</td>
<td>48,052</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>(83,178)</td>
<td>124,809</td>
<td>9,874</td>
<td>51,505</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>(81,705)</td>
<td>124,809</td>
<td>9,874</td>
<td>52,969</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>(81,714)</td>
<td>124,809</td>
<td>9,874</td>
<td>52,961</td>
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</tr>
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<td>2010</td>
<td>(81,722)</td>
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<td>9,874</td>
<td>52,962</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>(81,721)</td>
<td>124,809</td>
<td>9,874</td>
<td>52,962</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>(81,721)</td>
<td>124,809</td>
<td>9,874</td>
<td>52,962</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>(81,721)</td>
<td>124,809</td>
<td>9,874</td>
<td>52,962</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>(81,721)</td>
<td>124,809</td>
<td>9,874</td>
<td>52,962</td>
<td></td>
</tr>
</tbody>
</table>

NPV @ 12% 64,609
EIRR 17.2%

Table 5. Hengchang Copper (Y’000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost</th>
<th>O&amp;M Cost</th>
<th>Output</th>
<th>Other Saving</th>
<th>Net Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>(25,433)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(25,433)</td>
</tr>
<tr>
<td>2003</td>
<td>(53,854)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(53,854)</td>
</tr>
<tr>
<td>2004</td>
<td>(81,929)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(80,725)</td>
</tr>
<tr>
<td>2005</td>
<td>(60,469)</td>
<td>(13)</td>
<td>1,218</td>
<td>0</td>
<td>(59,577)</td>
</tr>
<tr>
<td>2006</td>
<td>(337)</td>
<td>1,218</td>
<td>11</td>
<td>18,358</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>(77,385)</td>
<td>94,906</td>
<td>892</td>
<td>20,570</td>
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</tr>
<tr>
<td>2008</td>
<td>(178,982)</td>
<td>197,797</td>
<td>1,756</td>
<td>37,273</td>
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</tr>
<tr>
<td>2009</td>
<td>(214,184)</td>
<td>249,246</td>
<td>2,212</td>
<td>48,893</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>(202,564)</td>
<td>249,246</td>
<td>2,212</td>
<td>48,893</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>(202,564)</td>
<td>249,246</td>
<td>2,212</td>
<td>48,893</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>(202,564)</td>
<td>249,246</td>
<td>2,212</td>
<td>48,893</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>(202,564)</td>
<td>249,246</td>
<td>2,212</td>
<td>48,893</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>19,956</td>
<td>(152,390)</td>
<td>249,246</td>
<td>2,212</td>
<td>119,024</td>
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</table>

NPV @ 12% 26,629
EIRR 14.2%
### Table 6. Shanjiang Chemicals (Y’000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost</th>
<th>O&amp;M Cost</th>
<th>Copper Saving</th>
<th>Energy Saving</th>
<th>Net Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>(27,667)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(27,667)</td>
</tr>
<tr>
<td>2003</td>
<td>(90,731)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(90,731)</td>
</tr>
<tr>
<td>2004</td>
<td>(119,879)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(119,879)</td>
</tr>
<tr>
<td>2005</td>
<td>(80,365)</td>
<td>(64,805)</td>
<td>104,848</td>
<td>2,828</td>
<td>(37,494)</td>
</tr>
<tr>
<td>2006</td>
<td>(78,707)</td>
<td>135,376</td>
<td>3,652</td>
<td>60,320</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>(71,323)</td>
<td>135,373</td>
<td>3,651</td>
<td>67,702</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>(71,340)</td>
<td>135,373</td>
<td>3,651</td>
<td>67,685</td>
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<tr>
<td>2009</td>
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<td>135,373</td>
<td>3,651</td>
<td>67,668</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>(71,376)</td>
<td>135,373</td>
<td>3,651</td>
<td>67,650</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>(71,370)</td>
<td>135,373</td>
<td>3,651</td>
<td>67,655</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>(71,370)</td>
<td>135,373</td>
<td>3,651</td>
<td>67,655</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>(71,370)</td>
<td>135,373</td>
<td>3,651</td>
<td>67,655</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>29,779</td>
<td>(47,938)</td>
<td>135,373</td>
<td>3,651</td>
<td>120,865</td>
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</table>

NPV @ 12% 85,399
EIRR 17.6%

### Table 7. Zhengxing Materials (Y’000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost</th>
<th>O&amp;M Cost</th>
<th>Output</th>
<th>Energy Saving</th>
<th>Net Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>(24,720)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(24,720)</td>
</tr>
<tr>
<td>2003</td>
<td>(81,312)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(81,312)</td>
</tr>
<tr>
<td>2004</td>
<td>(147,196)</td>
<td>542</td>
<td>0</td>
<td>0</td>
<td>(146,654)</td>
</tr>
<tr>
<td>2005</td>
<td>(31,830)</td>
<td>(344)</td>
<td>0</td>
<td>0</td>
<td>(32,174)</td>
</tr>
<tr>
<td>2006</td>
<td>(276,192)</td>
<td>302</td>
<td>10,131</td>
<td>36,339</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>(312,433)</td>
<td>403,200</td>
<td>13,507</td>
<td>104,274</td>
<td></td>
</tr>
<tr>
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<td>(339,900)</td>
<td>453,600</td>
<td>15,196</td>
<td>128,896</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>(353,646)</td>
<td>478,800</td>
<td>16,040</td>
<td>141,193</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>(349,209)</td>
<td>478,800</td>
<td>16,040</td>
<td>145,631</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>(349,203)</td>
<td>478,800</td>
<td>16,040</td>
<td>145,637</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>(349,203)</td>
<td>478,800</td>
<td>16,040</td>
<td>145,637</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>(349,203)</td>
<td>478,800</td>
<td>16,040</td>
<td>145,637</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>23,560</td>
<td>(262,532)</td>
<td>478,800</td>
<td>16,040</td>
<td>254,866</td>
</tr>
</tbody>
</table>

NPV @ 12% 325,891
EIRR 27.5%
and practices. An extended analysis did incorporate benefits to the global environment, but only those "global" benefits that could be associated with the PRC.

The economic analysis focused exclusively on the obvious and easily quantifiable economic benefits of the Project, namely the benefits of improved efficiency and productivity at the enterprises. The economic analysis was subject to a minimum rate of return of 12 percent, and it exceeded that by a wide margin, using only the benefits to the enterprises. The analysis focusing on the enterprises provided a sufficient economic basis for the Project, and no further economic analysis would have contributed to the decision making process.

The Project also indicates the kind of simple economic analysis that may be applicable for environmental problems in Asia in general, beyond the bounds of ADB. Acid rain is a severe environmental problem in Anhui Province, but is comparable in severity to other environmental problems in the PRC, and in the less developed countries of Asia in general. To some extent, the current economic status of the less developed countries of Asia results from the poor economic policies of the past. These policies allowed economies to develop severe inefficiencies and externalities, like those addressed in the Project. Environmental management in Asia is still developing, and so the first tasks will be to address the largest inefficiencies and externalities. Where the environmental problems are severe, like in the Project, the solutions will be obvious, and only very simple methods of economic analysis will be required. Of course ADB is not always involved in economic and environmental problems that are so severe, so economic analysis is not always so easy and obvious.

IV. The Future of Environmental Projects and Environmental Economics at ADB

ADB’s goals for Asian development ensure that ADB will continue to be involved in environmental projects in the Asian and Pacific region. In fact ADB’s forthcoming Environment Policy (2002b) may increase ADB’s involvement in the environment. The new policy is largely consistent with ADB’s previous environmental initiatives, and clearly spells out that ADB’s environmental operations will be oriented to policy reform and capacity building, focusing especially on management of natural resources (especially community-based management), environmental quality (pollution control), and natural hazards (droughts, floods, etc.).

In the future, ADB will continue to be involved in project-based lending in environmental areas. Table 8 shows the kinds of environment projects that are currently in ADB’s project cycle. These projects are not specifically environment projects, but rather projects that may have positive environmental impacts. ADB’s biggest involvement will be in power projects, focusing mainly on transmission and distribution. ADB’s power projects typically involve improving the efficiency of the power system, and so have a positive environmental impact through reducing power generation.

<table>
<thead>
<tr>
<th>Type of Project</th>
<th>Number of Projects</th>
<th>Loans (US$ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (T&amp;D)</td>
<td>23</td>
<td>2475</td>
</tr>
<tr>
<td>Water Supply and Sanitation</td>
<td>14</td>
<td>625</td>
</tr>
<tr>
<td>Wastewater Management</td>
<td>6</td>
<td>650</td>
</tr>
<tr>
<td>Water Resources</td>
<td>11</td>
<td>725</td>
</tr>
<tr>
<td>Natural Resources</td>
<td>11</td>
<td>508</td>
</tr>
<tr>
<td>Urban Environment</td>
<td>5</td>
<td>400</td>
</tr>
</tbody>
</table>

Water-related projects slightly outnumber power projects, but involve slightly less funding. Water supply and sanitation projects typically involve improving access to potable water in rural areas, and developing relatively simple facilities for disposing wastewater and solid waste. Wastewater management projects occur only in large cities with well-developed water supply systems, but often with poor or nonexistent drainage and wastewater treatment; five of the six anticipated wastewater treatments projects are in the PRC. Water resource projects include investments in infrastructure for flood control (for example, levees and revetments), irrigation projects, and also upper watershed management.

The projects in natural resource management (not counting water resources) are typically fisheries and agroforestry projects. These projects usually involve infrastructure development, capacity building, and extension of new farming and fishing practices. Such projects have the potential for the greatest direct impact on the poor, relative to the other kinds of projects listed in Table 8.

Finally, the projects listed under “urban environment” typically involve improvements to urban infrastructure—roads, sewers, and the like. Such projects are called “urban environmental improvement” because they aim to improve the quality of many different urban services in one city, or one area of a city.

The kind of economic analysis that ADB will use to evaluate these future projects is similar to the analysis described in the two previous sections of this paper—that is, the analysis will focus on direct and easily measurable benefits, and especially benefits for the poor. Economic analysis of the power projects will focus on the resource cost savings, with the positive environmental impacts as an ancillary benefit; the environmental impacts need not be expressed in monetary terms if the resource cost savings provide a sufficient economic basis for the project. The water supply and sanitation projects will focus on resource cost savings for the rural poor, plus consumer surplus from any increase in supply; information to support both kinds of benefits will generally come from household surveys.

Wastewater management projects occur only in places with reasonably well-developed environmental management regimes. As such, economic analysis of the projects may be based largely on a project’s role in the existing regime. Such an analysis may not require expressing the
environmental impact in monetary terms, and may involve only a least-cost analysis (Dole 2002).

Economic analysis of water resource and other natural resource projects typically involves as much agricultural economics as resource economics. Such projects typically involve displacement or enhancement of agricultural enterprises (especially small, poor farmers). Estimating the costs and benefits therefore involves estimating the potential gross profit per unit area.

Urban environmental projects may involve the most advanced or sophisticated methods of measuring economic benefits. Urban infrastructure, of course, influences property values, and so project analysis can make use of hedonic pricing methods.

Future research in environmental economics can contribute in various ways to ADB’s efforts to protect and improve environmental quality in Asia (as well as many efforts outside of ADB). Methods for measuring the monetary value of environmental impacts are, of course, already well established. ADB’s needs are served largely by simple methods.

Perhaps the biggest constraint on economic analysis is the availability of reliable data. Obtaining reliable data is a costly and time-consuming exercise anywhere, but the difference between Asia and the developed world is that reliable data already exists in the developed world (at least sometimes). Project analysts in Asia and other developing countries often must collect their own data. Since collecting data is expensive and time-consuming, analysts must get by with relatively little of it. Research on methods to collect and analyze small amounts of data could contribute greatly to project analysis at ADB.

V. Environmental Economics in Policy Development and Analysis

This paper has focused on the role of environmental economics in project analysis, but environmental economics can also contribute to ADB’s efforts to improve the policy and institutional framework of environmental protection in the Asian and Pacific region. Although ADB’s main operations focus on lending, ADB also provides and administers grants for technical assistance. In 2000, for example, ADB approved 305 grants, totaling US$172 million (ADB 2001a). The grants supported environmental activities such as building capacity for environmental management in the Philippines, and in Indonesia (the vast majority of grants, though, were not related to environmental issues). Some grants are used to support the development of a project to be funded by an ADB loan, as mentioned previously, but most grants are used to develop the policy or institutional framework of a country.

Environmental management in the countries of the Asian and Pacific region is in different stages of development, just as the economies themselves are in different stages. The theory of environmental policy is well developed, but it was developed in countries with already strong social and institutional infrastructure. Developing countries in Asia and elsewhere, in contrast, often have a weak or nonexistent foundation for building an environmental management regime. For example, the common prescriptions for market-based instruments make sense in developed countries, where permit trading could be introduced as an adjustment to a
pre-existing emissions permit system. In contrast, permit trading in a developing country may be justifiable not as an improvement to an existing management regime, but as the initial regime, where no other policy is able to overcome the social, cultural, or political barriers to developing a centralized management system, with reliable monitoring and enforcement. Policies relying on private compliance may not be effective where laws are not widely respected or obeyed, or where policing is corrupt or ineffective. Environmental information campaigns may not be effective where government-supplied information is not credible, or where people are not inclined to exert their individual rights. Environmental policies cannot and should not tackle these much broader social problems, although they may contribute to general efforts to tackle such problems. Environmental policies, however, can play an important role in tackling environmental externalities. The scale of these externalities means that they need to be dealt with in a systematic way through the establishment of a comprehensive set of appropriate rules, regulations, and laws to regulate, monitor, and enforce the behavior that causes environmental externalities. Perhaps the biggest question for environmental policy in developing countries is not how to improve an existing system, but rather how to build a system relative to a country’s given economic, social, and political status.

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