Economic Evaluation of Investment Projects
Possibilities and Problems of Applying Western Methods in China

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of Applying Western Methods in China

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Abstract

This paper, written originally for a Chinese audience, is a simple description of economic cost-benefit analysis, coupled with a discussion of its applicability to project appraisal in China. It is concerned mainly with methods of estimating shadow prices for project inputs and outputs, particularly in light of the size and non-market nature of China's economy. Most of the exposition is narrowly economic in the sense of assessing a project's impact on the level of national income, without regard to its distribution, but the relevance to China of social evaluation is also discussed, as is the need to combine other criteria with the results of formal economic analysis in making investment decisions. An annotated bibliography is included.

EXTRACTO

Este documento, escrito originalmente para un público chino, es una descripción sencilla del análisis económico de costo-beneficio, acompañada de una exposición de las posibilidades de su aplicación a la evaluación de proyectos en China. El documento trata principalmente de los métodos de estimación de precios sombra para insumos y productos de los proyectos, en especial a la luz de la magnitud de la economía china y su carácter de economía no de mercado. En su mayor parte, la exposición es estrictamente económica en el sentido de que evalúa las repercusiones de un proyecto sobre el nivel del ingreso nacional, sin considerar su distribución, aunque trata también de la importancia que tiene para China la evaluación social, al igual que la necesidad de combinar otros criterios con los resultados del análisis económico formal al hacer decisiones en materia de inversiones. Se incluye una bibliografía anotada.

Ce document, écrit à l'origine à l'intention de lecteurs chinois, est une description sommaire de l'analyse des coûts et avantages économiques, accompagnée de l'examen de son applicabilité à l'évaluation des projets réalisés en Chine. Il porte principalement sur les méthodes d'estimation des prix de référence des intrants et des extrants des projets compte tenu, en particulier, de la taille du pays et du caractère planifié de son économie. La présentation est en majorité de nature strictement économique en ce sens qu'elle évalue les effets d'un projet sur le revenu national, sans considération de répartition de ce revenu; toutefois, elle examine également la mesure dans laquelle une évaluation sociale peut s'appliquer à la Chine, ainsi que la nécessité de tenir compte d'autres critères en plus des résultats de l'analyse économique lorsqu'il s'agit de prendre des décisions en matière d'investissement. Le document s'accompagne d'une bibliographie annotée.
Acknowledgements

This paper was originally written as background material for a team of Chinese experts preparing a project appraisal manual for the China Investment Bank. The manual covers technical, market and financial, as well as economic, evaluation; but is more closely focussed on the requirements of an industrial investment bank. The author of the present paper is a member of the staff of the World Bank, and is much indebted to many World Bank colleagues for comments and suggestions, as well as to various World Bank publications. Nonetheless, this paper represents his personal views, not those of the World Bank or its member governments. The author also gratefully acknowledges the substantial contribution that the Chinese expert team and other Chinese colleagues have made to this paper. But he alone takes responsibility for its deficiencies.
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Introduction

1. During the past twenty years, Western and East European countries have developed new methods of assessing the contribution of prospective investment projects to growth of national income and other economic objectives. Economic evaluation, as this is called, is a familiar idea in China. But the new methods may be useful as a supplement to the methods already used by Chinese planners. In particular, the Western emphasis on efficiency could complement the emphasis on quantities and balances that is the central feature of Chinese planning. It could help to ensure that socialist plans and priorities are implemented without waste of national resources.

2. An "investment project" need not be a completely new undertaking. The new methods of economic evaluation can be applied also to investment in the replacement of old equipment, the expansion of an enterprise, or the completion of an unfinished project. In addition, they can be used to investigate the operations of existing enterprises, to assess their economic viability, and hence to contribute to decisions on restructuring and closure. All these issues are important to China's modernization; and some of them cannot satisfactorily be addressed by the methods of economic evaluation currently used in China.

3. This paper is no more than a brief introduction: for further information on the new methods, the reader should consult the items in the bibliography (some of which are available in Chinese). Moreover, it is restricted to economic evaluation. Thus, it does not cover some essential
aspects of project appraisal, including the assessment of technical soundness, market size and input availability. It takes for granted that the choice of technology, scale, timing and location for each project should be based on a systematic review of alternatives. And it assumes some knowledge of the concept of "sunk costs", as well as of the ("incremental" or "marginal") principle of assessing the results of a project by comparing the future situation with the project to the future situation without the project. These excluded subjects are dealt with in some of the items in para. 107 of the bibliography.

**Economic Profitability**

4. Western economic evaluation attempts to measure the profitability (the excess of benefits over costs) of a project to the whole economy or society. The immediate result is a number – expressed in millions of yuan, or as a percentage of the investment involved – that can then be compared with the corresponding numbers for other projects, and with other yardsticks, to assist in deciding whether or not the project in question should be undertaken. Since it is future profitability that is being measured, and since the future is inevitably uncertain, it is also usual to assess the riskiness of the project by recalculating its profitability under a range of plausible alternative assumptions regarding key influences on its benefits and costs. This is often called sensitivity analysis.

5. Profitability calculations – whether applied to projects or to enterprises – are familiar in China. But Western methodology contains two innovations.
6. The first is the use of discounted cash flow techniques for measuring profitability. These techniques (see para. 107 of the bibliography) overcome certain deficiencies of conventional accounting measures of profitability, and in particular make allowance for the time value of money - that is, for the obvious fact that it is better to receive a given amount of profit sooner rather than later. But the resulting, more accurate, measures of profitability have much the same meaning as their conventional counterparts: net present value, measured in millions of yuan, is similar to total profits (net of depreciation and interest) over the lifetime of the project; while the internal rate of return is similar to annual profits expressed as a percentage of the investment cost of the project. Thus the use of discounted cash flow methods is not confined to economic evaluation; and it is possible - though not usual - to undertake economic evaluation in a conventional accounting framework.

7. The second innovation is much more fundamental, and lies at the heart of Western economic evaluation. It is the replacement, in calculating the economic profitability of investment projects, of actual prices with shadow prices (also known as accounting prices or adjusted prices). The reason is that actual prices may be a poor guide to economic benefits and costs. In China, for example, the prices of necessities are set low, despite their economic importance, while the prices of less essential goods are set high. Similarly, for historical reasons, many energy and raw material prices are irrationally low, while the prices of some other goods are excessive. As a result, some projects which appear very profitable when their outputs and inputs are valued at actual prices are in
fact unattractive from the viewpoint of the national economy, while some apparently unprofitable projects have high economic returns.

8. Such divergences between economic returns and profitability at actual prices are well understood in China. The response of Chinese planners since 1949 has accordingly been to rely very little on profitability as a guide to investment (and other economic) decisions, and to focus instead on the economic contribution of projects in relation to the quantitative and qualitative targets of the plan. Planning has also been adopted in many Western countries, especially in developing nations. But as part of their work, Western planners have continued to make calculations of profitability, using shadow prices that more accurately reflect the economic benefits and costs of project outputs and inputs. (Western planners have also continued, for other purposes, to calculate profitability at actual prices: this is sometimes called financial evaluation - see paras. 89-94).

9. The difficult part of this sort of economic evaluation is to estimate appropriate shadow prices - which is what most of the present paper will be concerned with. Once this is done, the calculation of economic profitability is very simple. The physical quantities of output produced each year by the project, and the physical quantities of inputs consumed, are all valued at their particular shadow prices. The same is done for machinery, construction and other investment costs. The resulting data on revenues, operating costs, and investment expenditures in each year of the project's life are then assembled in a projected cash flow table (or
possibly in a more conventional projected profit and loss statement. The sum of the items in each year, which is called the net cash flow, shows the profitability of the project in that year - negative during the implementation period, positive after the start of production. From this information on annual profits, one or more of the summary measures of profitability discussed earlier (e.g., net present value, internal rate of return) can then be calculated.

Shadow Prices and World Prices

10. Shadow prices depend on economic circumstances, but also on economic and social goals: even in a given country at a given time, the way in which benefits and costs are evaluated must depend on what the planners want to achieve. But it is usually assumed that the main goal is to increase the total net output of the economy. (Other possible assumptions are considered below, in the section on "social evaluation"). This dictates a particular set of principles for estimating shadow prices. The shadow price of project output should reflect its contribution (if a producer good) to production in other enterprises or industries, or (if a consumer good) to the social value of consumption. Similarly, the

\[1\] In the last year of the project's life, one should include on the benefit side its estimated scrap value, including recovery of working capital. The project's length of life, incidentally, should ideally be derived from the economic evaluation, taking account of rising real wages, maintenance and replacement costs. Specifically, a project should cease operating when its net cash flow at shadow prices drops to zero. In practice, since discounting at the usual rates greatly reduces the impact of more distant cash flows, rather arbitrary assumptions about project life are common - though shorter lives are normally assumed in sectors where technical progress is expected to be particularly rapid, and vice versa.
shadow price of each input should reflect the contribution that it would have made to production had it not been used up in this project. With outputs and inputs valued on these principles, one can assess how much a project would add to other production, how much it would subtract from other production, and hence what would be its net contribution to national output.

11. In practice, there are obvious difficulties in applying these principles for estimating shadow prices. To make a direct estimate of the contribution of even one project output or input to total national production would require an enormous amount of information on the economic linkages between this project and other parts of the national economy, and the use of advanced computational techniques. For this reason, and despite much theoretical work on shadow prices, no country has succeeded in calculating an ideal set of shadow prices for practical use.

12. Instead, as a second-best method which combines some theoretical strong points with the great advantage of practicality, economic evaluation in Western and East European countries has used world prices as the main basis for calculating shadow prices. As will be explained below, world prices are used directly as shadow prices for some outputs and inputs; for others, shadow prices are estimated by combining information on world prices with other information on the national economy; and yet other shadow prices may be estimated without reference to world prices.

/1 This is often referred to as its "opportunity cost".
13. World prices are not ideal prices from the viewpoint either of individual developing countries or of the world as a whole. But they are usually beyond the control of individual countries, and are thus a very important aspect of the economic opportunities and constraints with which a country engaged in international trade is confronted. For example, China is buying and selling abroad at prices that imply that it is exchanging one barrel of petroleum for 24 kg of aluminum; could substitute 80 kg of imported cotton for one ton of imported wheat; and could earn as much by exporting 110 kg of rice as by exporting one ton of coal. If good use is to be made of national resources, decisions about production and consumption of these commodities should be influenced by these relative prices (which would in fact be the shadow prices of exports and imports in a linear programming model of the economy).

14. Naturally, world prices should be only one of several influences on economic decisions. Thus, as mentioned above, other considerations should enter into the estimation of shadow prices (and of course into the setting of actual prices). More importantly, the resulting calculations of economic profitability cannot be the exclusive guide to project selection and other choices, but must be combined with other economic and noneconomic considerations, including the priorities, policies and plans laid down by the state. But in conjunction with other sorts of evaluation and analysis, calculations of economic profitability based (wholly or partly) on world prices can be very useful.

15. Such calculations are indeed already made in China, under the name of "foreign exchange analysis". In particular, it is quite common, when
evaluating a project, to estimate its contribution to earning or saving foreign exchange through exports or import substitution, and to compare this with the foreign exchange cost of the capital equipment involved. Rough calculations of foreign exchange profitability are then made, usually in terms of the speed with which the foreign exchange earnings or savings will offset the cost of the imported equipment.

16. These familiar calculations, based on world prices, are thus quite closely related to Western methods of economic evaluation. But simple foreign exchange analysis of the sort now done in China has two serious deficiencies.

(a) It neglects indirect foreign exchange effects of various sorts. One is where the output of the project is sold domestically for use by exporters. Another is where the output of the project is sold on the domestic market, but permits other enterprises producing the same product to divert their output to the export market. A third is where a project uses an input that is domestically produced, but could otherwise have been exported (e.g., coal or oil). A fourth is where a project uses a domestically supplied input whose production requires the use of imports or of goods which could otherwise have been exported. And so on. It is thus not difficult to find cases where simple foreign exchange analysis is misleading: on the one hand, there are projects whose direct foreign exchange effects are positive, but which directly and indirectly absorb more foreign exchange than they generate; on the other hand, there are projects whose direct foreign exchange effects are negative, but which directly and indirectly make a positive contribution to the foreign trade balance.
Simple foreign exchange analysis also neglects the costs of using domestic resources such as labor, land, and savings. This could lead to bad project choices even if all direct and indirect foreign exchange effects were accurately measured. For example, consider two alternative projects, each of which required $10 million of imported capital goods and earned $1 million in foreign exchange each year. On foreign exchange grounds alone, they look equally good. But one might require a labor force of 5,000 people, 500 mu of land, and ¥20 million of construction and locally produced equipment; while the other might require only 1,000 people, 50 mu of land, and ¥5 million of local investment.

Western economic evaluation, as it is used in practice, is in essence an extension of simple foreign exchange analysis that attempts to overcome these two basic deficiencies, and hence to provide a more reliable guide to project selection and other economic decisions. The rest of this paper explains the methods used: specifically, it explains how shadow prices are estimated for various sorts of outputs and inputs—traded goods, wages, land, interest, and nontraded goods. It then discusses externalities, social evaluation and project selection criteria.

The following sections may suggest to some readers that calculations of economic profitability are impossibly difficult and time-consuming. In fact, this is not so. Economic evaluation is much easier to do (especially after a little practice) than to describe. This is partly because the more complicated aspects of shadow pricing are in practice often the least important, and partly because there are various simplifications and shortcuts that can usually be applied without too much fear of error. The methods described below should thus be interpreted not as rigid rules to
be followed in detail for every project, but as principles to be applied with good judgment and due regard to the varying circumstances of particular projects.

Traded Goods

19. An initial, basic step in economic evaluation is to divide the various project outputs and inputs into two broad categories - traded goods, and everything else. A traded good is one whose production or use will affect China’s exports or imports of the good concerned. An obvious example is where capital equipment for the project is bought from abroad, or where part of the output of the project is directly exported. Similarly, one would categorize as traded an input such as petroleum which would otherwise have been exported, or an output such as wheat whose increased domestic production reduces the level of imports below what it would otherwise have been.

20. One should not categorize as traded a good which is bought and sold in international markets, but not by China. For example, if China were as a matter of policy to maintain complete self-sufficiency in a certain organic chemical, it should be treated as a nontraded good. To see why, suppose that the relevant section of the Chinese chemical industry was by international standards inefficient (perhaps through being too small to realize important economies of scale), and was expected to remain so for the next 20 years. Then in evaluating a project for which this chemical was a major input, one should set its shadow price not at the world price, but at the - higher - shadow cost of producing it in China (the methodology is
described in para. 55). Hence, the project would - correctly - be revealed as less attractive in economic terms than it would be if imports were the residual source of supply of the chemical concerned, and were accordingly shadow priced on the basis of the world price./

21. In deciding whether or not a good should be categorized as traded, it helps to know whether or not China is currently exporting or importing it. But occasionally imports are limited by rigid long-term quotas, in which case the goods concerned should be treated for purposes of project analysis as nontraded. It is also necessary to look ahead - for example, might imports of a particular good be prohibited in the near future; or might there be exports or imports of a good that is currently not traded? In addition, it may be necessary to look at the pattern of internal trade. Because China is a large country, with high transport costs and a tradition of local self-sufficiency, there may be cases where the production or use of a good in a particular locality will not affect the country’s foreign trade, even though that good is being exported or imported in other localities.

22. It is thus necessary to use judgement in categorizing the inputs and outputs of particular projects as traded or nontraded. But even with good information and judgement, the answer is not always obvious. In such

/1 This in turn (in all countries) raises the basic question of whether or not the project analyst should take foreign trade policy as given - since doing so will cause him on economic grounds to reject some otherwise good projects, and to accept some otherwise bad projects. The usual answer is that in such cases the analyst should clearly state that his conclusion depends on the maintenance of a particular foreign trade policy, and should present calculations showing the economic results under an alternative policy (such as giving a project special permission to import some input). However, if this statement leads to no change in the policy concerned, then the analyst should stick to his original conclusion.
cases, it is generally advisable to assume that the good concerned is traded, simply because the procedures for shadow pricing nontraded goods are generally more complicated.

23. **Adjusted World Prices.** The shadow price of a traded good in the context of a particular project should be its world price, net of any Chinese tariffs or taxes, adjusted for international and internal transport and distribution costs.\(^1\) This will be called the **adjusted world price.** For an export, it would be the f.o.b. price at the nearest port (or, where relevant, airport) minus the costs of getting the commodity from the project site to the ship's hold. For an import, it would be the c.i.f. price at the nearest port plus the costs of getting the commodity from the ship's hold to the project site.\(^2\) As this implies, the shadow price of a traded commodity will depend on whether it is an export or an import, and will also vary from place to place in China.

24. For imported capital equipment, a firm price at the expected delivery date is often quoted. But for other inputs and outputs, it is desirable to consider not only the current world price, but also the future course of world prices over the expected life of the project, especially if

\(^1\) Internal transport and distribution costs should in principle be valued at shadow prices, as described in paras. 65-66 below.

\(^2\) For an export substitute (i.e. a project input that reduced the level of exports), the adjusted world price should be the f.o.b. price at the port nearest the supplier of the input minus the costs of getting the commodity from the supplier to the port plus the costs of getting it from the supplier to the project site. Similarly, for an import substitute (i.e. a project output that reduced the level of imports), the adjusted world price should be the c.i.f. price at the port nearest to the main buyer of the project's output plus the costs of getting the commodity from the port to the buyer minus the costs of getting it from the project site to the buyer.
there is reason to suppose that the relative price of the good concerned is temporarily elevated or depressed (for example, because of dumping) or will exhibit a strong trend (for example, because of unusually rapid or unusually slow productivity growth in the sector concerned). A project that seems attractive (or unattractive) at today's prices may become unattractive (or attractive) when shadow prices are adjusted to reflect expected changes in world market conditions.

25. It is sometimes also important to allow for the effect that the project itself will have on world prices, for example, where one of its outputs or inputs constitutes a significant fraction of world trade in some standard commodity such as cotton, or is supplied to some specialized foreign market such as that for Chinese foodstuffs, or to a market restricted by import quotas in other countries. In such cases, the shadow price of the good concerned should reflect the impact of the project not only on the price of its own output or input but also on the revenues or costs of other Chinese exporters or importers. For instance, if the output of a project were expected to depress the world price of a Chinese export, the shadow price of the good concerned should be based on the expected new price minus the decline in existing export revenues (which is the expected change in price multiplied by the quantity that would be exported in the absence of the project).

26. Information on current and future world prices is available from various sources, including the Ministry and Bureaus of Foreign Trade, and international organizations such as the World Bank, as well as from foreign
governments, enterprises, trade associations, trade journals, and consultants. In general, there is more published information on primary commodities than on manufactured goods, partly because the latter are so numerous and diverse. Thus it may be necessary to make special studies of the price prospects for particular goods. More generally, it must be recognized that the future cannot be accurately predicted, and that different forecasts may be obtained from different sources. Judgment is thus required (although all Chinese project analysts should try to use the same assumptions regarding particular world prices). It is also usually desirable to evaluate the attractiveness of a project under alternative assumptions about future world prices.

27. For many internationally traded goods, there is not one price, but several, according to quality. It is therefore essential, in attaching shadow prices to traded outputs and inputs, to base them on the world prices of goods of comparable quality. However, some Chinese manufactured goods, because of outdated technology or design, are of worse quality than any of their internationally traded counterparts. A problem thus arises when a project input or output, though traded in the sense that its use or production will have a commensurate effect on the volume of good quality imports or exports, is in fact a domestically produced substitute of lower quality. /1 In such cases, the shadow price of the good concerned should be

/1 This problem arises most commonly with project inputs - in particular, where the supply of the low quality domestic substitute is fixed by the amount of capacity installed in the past, new domestic production being of international quality. (Where low quality domestic production continues to expand, then for purposes of project evaluation one should treat the inferior product as a separate, nontraded good - paras. 54-69.) But the same problem may arise with project outputs, especially in rehabilitation or modernization projects, and where the use of an inferior domestic input (for example, machinery or components) results in output of substandard quality.
set below the world price of its better quality substitute. To determine an appropriate price differential, it is sometimes possible to work on the basis of relative market prices in other countries where domestically produced goods of similarly low quality compete in the domestic market against goods of internationally traded quality. Another approach, especially relevant to producer goods, is to measure the impact of using a low quality input rather than a high quality input on other costs of production - for example where the use of inferior paper requires packaging machinery to be run at half speed and hence twice as many machines and men are needed to achieve the same volume of output. For consumer goods, aspects of quality such as durability can be objectively measured; but superior appearance and style can be valued only subjectively - for example, on the basis of market surveys.

28. In economic evaluation of projects, which hinges on the relative prices of outputs and inputs, it is customary to abstract from the effects of general inflation, both foreign and domestic. Thus, most "price contingencies" should be removed from estimated investment costs. Similarly, the future world prices for a traded good, if not already expressed in "constant dollars," should be deflated by some suitable index of expected world
inflation. The world price in foreign currency should then be converted into renminbi at the current official exchange rate.\(^1\)

29. **General Conversion Factors.** The procedure for estimating shadow prices described above should normally be applied only to the major traded outputs and inputs of the project concerned - typically comprising imported capital equipment, the principal product, the main raw material, and oil or coal. There may also be many smaller traded inputs or outputs: but in

\(^1\) In all the calculations described in this paper, the official exchange rate is used to convert between foreign exchange and renminbi. A possible alternative would be to use the internal settlement rate. For the most part, it makes no difference what exchange rate is used in these calculations. In particular, the exchange rate would not affect a project's economic attractiveness if the shadow prices of all its outputs and inputs were (directly or indirectly) related to world prices, which is recommended wherever possible in this paper. But the choice of exchange rate does make a difference when, for theoretical or practical reasons (such as lack of time, or lack of information for calculating suitable general conversion factors), some of a project's outputs or inputs are not shadow-priced, but have to be valued at actual Chinese prices. In these circumstances, one should use an exchange rate that on average across all traded goods makes Chinese prices equal to adjusted world prices. The level of this equalizing (or shadow) exchange rate cannot be accurately determined without substantial further empirical work. But on the basis of fragmentary evidence, it currently seems to lie closer to the official exchange rate than to the internal settlement rate. Use of the official exchange rate in all calculations is thus provisionally suggested as the more accurate of these two alternatives.

It should also be pointed out that use of the current exchange rate in all calculations implicitly assumes that the rate will be adjusted from time to time in such a way as to offset the excess of world inflation over Chinese inflation - thus maintaining a constant real exchange rate. The implications of this assumption not being fulfilled are closely related to those of the choice between alternative exchange rates discussed above. Fluctuations in the real exchange rate would not affect a project's economic attractiveness if all the shadow prices involved were directly or indirectly related to world prices; but would make a difference if the shadow prices of certain outputs or inputs were related instead to actual Chinese prices.
general, it is more trouble than it is worth to estimate their adjusted 
world prices individually; instead, the recommended practice is to group 
them together and to multiply their value or cost at Chinese prices by a 
"general conversion factor," which is simply an estimated average ratio of 
adjusted world prices to Chinese prices.

30. Since the relative prices of different sorts of commodities in 
China differ substantially from relative world prices, one should apply 
different general conversion factors to different groups of goods. 
Appropriate groupings should emerge from empirical research on the relation-
ship between Chinese and adjusted world prices, and could be quite detailed. 
At a minimum, it would be important to distinguish between agricultural and 
industrial products; and probably also within the latter category between 
consumer goods, primary products, basic intermediate goods, and machinery.

31. For each commodity grouping, the general conversion factor should 
be estimated from as representative a sample of items as possible. The best 
way to do this is through systematic research; otherwise, one might draw on 
work previously done to calculate the shadow prices of specific traded goods. 
For each individual commodity, the relevant ratio is obtained by dividing its 
current adjusted world price, converted into renminbi at the official 
exchange rate, by (in the case of an export or export-substitute) the price 
actually received by Chinese producers or (in the case of an import or 
import-substitute) the price actually paid by Chinese users. The general 
conversion factor for the group is a suitably weighted average of all the 
individual ratios.
32. The same general conversion factors should be used to evaluate all projects in a given locality. (A "locality" in this context might be a municipality, or a group of rural counties—perhaps a prefecture.) Thus they should be estimated not by individual project analysts, but by the local branch of some relevant government agency. Indeed, as an initial approximation, it might be acceptable to use the same general conversion factors throughout China. But they should be periodically revised to reflect changes in world prices, Chinese prices and the exchange rate.

33. In other countries, general conversion factors are sometimes estimated on the basis of average tariff and export tax rates—on the assumption that these are the main cause of differences between world prices and domestic prices. This assumption is incorrect in many developing countries, and would be extremely misleading in China, where most domestic prices are set without reference to world prices. Thus, this shortcut method of estimation should not be used.

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1 General conversion factors would be similar in all localities if (a) distribution margins were similar; (b) actual price differences between localities reflected internal transport costs; and (c) the commodity composition of each grouping were similar. These assumptions are not accurate for China—but they are probably not grossly inaccurate.

2 Unlike the shadow prices of individual traded goods, general conversion factors are for simplicity normally (a) estimated on the basis of current rather than future prices; and (b) assumed—like the real exchange rate—to remain constant throughout the life of a project. For consistency, in constructing the projected cash flow table, one should also assume that the actual domestic prices of minor traded items remain constant.
34. Another quite common shortcut method is to calculate only one general conversion factor (for all traded commodities), and to base it on an estimated shadow exchange rate. More exactly, the single general conversion factor is calculated as the ratio of the official exchange rate to the rate prevailing in some free or "parallel" foreign exchange market. This method is of dubious validity in most countries, since restrictions on foreign exchange transactions in the parallel market often cause the market-clearing rate to be a poor guide to the average relationship between world prices and domestic prices. It seems clearly inapplicable to China, for two reasons. The first is that, as noted earlier, internal relative prices in China differ so substantially from relative prices in world markets that any single conversion factor is liable to be seriously misleading. The second is that there is no suitable parallel market. (There is of course an internal settlement rate, which is quite different from the official exchange rate. But there is little reason, either theoretical or empirical, to suppose that the internal settlement rate is such as to equalize the world and domestic prices of even the "average" traded commodity.)

Wages

35. In principle, the shadow wage rate is the amount that a worker employed by a project would have contributed to national production had he not been employed by this project. This measures the cost to the economy of his services to this project. One must therefore ask two questions:

   (a) Where are the workers on this project ultimately drawn from?
This requires knowledge of the labor allocation process, including policies
regarding migration or commuting from rural to urban areas, as well as of the economic conditions of the locality. Special attention should be given to indirect effects, as for example where the ultimate effect of recruiting a worker from another enterprise is to cause that enterprise to take on a new worker who would otherwise have been unemployed.

(b) How much would removal of some labor cause output to fall in the activity from which the workers for this project are being ultimately drawn? This, too, requires knowledge of local economic circumstances, both current and over the expected life of the project.

36. In China, unlike some other developing countries, the actual wages of many highly qualified staff may substantially understate their shadow wages, both because of past disruption of higher education and because the government has pursued an egalitarian wage policy. To estimate the relevant shadow wage, the project analyst could look at the cost of employing foreign consultants with similar qualifications, and perhaps also at the pattern of wages in other developing countries. In most projects, however, the wages of highly qualified staff are such a small proportion of total costs that it is not worth taking the time to adjust them for purposes of economic evaluation.

37. Adjusting the wages of other types of labor, by contrast, may have a considerable impact on the economic profitability of a project. In other countries, the most common adjustment is to set the shadow wage of unskilled and semiskilled labor well below its actual wage, on the ground that workers on the project will ultimately be drawn from among the unemployed or
underemployed, who would otherwise be producing very little. (The shadow wage is not normally set as low as zero, though, partly because even the nominally unemployed may be engaged in household or other work, partly because of training costs, and partly because people in active employment need to eat more and to be supplied with more public services than those who are idle.)

38. The same logic seems of relevance to China. Few people are completely unemployed, and some sorts of skilled manual and clerical workers are scarce. But most urban enterprises and organizations appear to have more employees than they need, and in many rural areas also a reduction in the labor force would have only a small effect on production. In many cases, it may therefore be appropriate to set the shadow wage below the actual wage, although this will depend on the nature of the project, the circumstances of the locality, and the skills of the workers concerned.

39. Since there is already a substantial surplus of labor in most Chinese towns and cities, and since migration from rural areas will usually be very limited, it seems likely that most projects in urban areas in the next decade will draw their workers mainly from among the urban underemployed — as for example where an enterprise could carry out an expansion project with no addition to its labor force, or by recruiting secondary schoolleavers who would otherwise have swelled the ranks of those awaiting permanent job assignments. But although the shadow wage of most types of urban labor must thus be presumed to be low, there is no obvious and simple method of estimating it in Chinese circumstances. Fortunately, for most industrial projects, in which labor is a small proportion of total costs, the level at which the shadow wage is set does not crucially affect
estimated economic profitability. It may thus be possible to use actual wages as shadow wages. In cases where the economic profitability of an urban project does hinge on the level of the shadow wage, setting it at half the actual wage (including bonuses and enterprise welfare expenditures) might be an acceptable alternative.\(^1\)

40. Where a project will draw its workers directly or indirectly from agriculture - because it is in a rural area, or in an urban area to which rural people are likely to be permitted to commute or migrate - the shadow wage should evidently be the contribution of marginal labor to agricultural output. This varies from place to place in China, depending on such things as the fertility of the land, its proximity to urban markets, and the density of population. The rural shadow wage should thus be estimated on the basis of local studies (and the comments of local experts) regarding the extent of surplus labor, bearing in mind the existence of private agriculture and nonagricultural activities as alternatives to collective agricultural work.\(^2\) A modest amount of empirical research will usually yield a reasonable estimate of the amount of output that would be lost through diversion of labor to the project. But, since the economic profitability of rural projects is often quite sensitive to the level of the shadow wage, it

\(^1\) An even smaller figure might be appropriate but for the fact that in China a variety of subsidies permit actual wages to be lower than in other countries with a comparable standard of living, thus narrowing the gap between actual wages and shadow wages. As regards state subsidies to housing and other public services, see also para. 47.

\(^2\) Attention should also be paid to the nature of the project. For example, a project that employed labor only at agriculturally slack seasons might involve a much smaller loss of output than one which employed labor throughout the year.
is usually worth experimenting with a range of plausible alternative estimates.

41. In estimating shadow wage rates, the output that is lost as a result of employment of labor by the project should whenever possible be measured not at Chinese prices but at adjusted world prices. This is relatively easy to do for rural labor, although conversion factors must be used carefully because of the existence of different procurement prices for quota, above-quota and negotiated sales of agricultural products. But in the case of urban labor, where the type (as well as the amount) of lost output cannot be accurately known, a comparable conversion may not be feasible.

42. All projects in the same (urban or rural) locality should in general be evaluated with the same estimated shadow wage rate (or rates - if more than one type of labor is involved). Moreover, the shadow wage rate should in principle usually rise over the life of the project, to reflect increasing labor productivity in other uses (and hence an increasing amount of lost output as a result of employment of labor by the project). A rising shadow wage could significantly alter the relative attractiveness of different projects, in particular by disproportionately reducing the economic returns to labor-intensive production. But it is hard to predict the rate of increase in the shadow wage. The best initial assumption is probably that it will rise at the same rate as average real output per worker is expected to rise in the medium-term national plan. This assumption could be modified to reflect the differing circumstances of particular localities.
Land

43. Since land is not privately owned in China, its acquisition or use for a project may entail no financial transaction - although in some cases rent is paid, as is compensation for requisitioned communal land. In almost all cases, however, the use of land involves an economic cost, since in the absence of the project it could have been used for some other productive purpose. Indeed, given the shortage of cultivable land in China, the cost may be high, and allowance should be made for it in calculating economic profitability.

44. For most agricultural projects, the best approach is not to make a special calculation of the value of the land, but instead to measure the annual benefits of the project as the difference between what the land would have produced in the absence of the project and what it is expected to produce as a result of the implementation of the project. For nonagricultural projects, however, one should estimate either an appropriate annual rent to be included in operating costs or an appropriate lump sum to be included in capital costs - unless of course the project uses no additional land (as for example where a second storey is added to an existing building, or some otherwise useless part of an existing site is brought into use, or new land is created by filling in a swamp).

45. If the nonagricultural project is in a rural area, an appropriate rent or lump sum can usually be calculated on the basis of the agricultural productivity of the site. The annual rent should be estimated as the gross value of output (ideally at adjusted world prices) less the costs of realizing this output, including shadow labor costs. Given the annual rent,
a suitable lump sum cost for the land could be derived, if desired, as the sum of the annual rents over the life of the project, discounted at the shadow interest rate (see below).

46. This approach is not so appropriate in urban areas. The ultimate effect of most urban projects may indeed be to encroach on agricultural land: even if a vacant urban site is used, this may eventually cause some other project to be set up in the rural suburbs. But to value an urban site on the basis of agricultural productivity might substantially understate the economic cost of using it, which is more likely to depend on its productivity in some alternative nonagricultural use. The absence of a market in urban land makes this difficult to measure in China, and even research into urban rents in other developing countries could provide no more than an approximate basis for judgment. Fortunately, however, in most industrial projects the economic cost of land is a fairly small part of total costs. Thus even if it is inaccurately measured, the resulting error is usually insignificant.

47. The preceding discussion relates to land alone. But in economic evaluation of a project one should also include an appropriate share of the capital cost of new roads, housing, schools or other infrastructure, even if this is actually paid for by some other agency. (An exception would be where the fees for services such as electricity and transport are sufficient to cover the capital costs concerned.) The use of existing buildings and infrastructure may also involve an economic cost, even if no new expenditure is needed. This is not related to original ("sunk") construction costs, but to current value in alternative productive uses. In
practice, because the latter is very hard to estimate in China, it may have to be ignored.

Interest

48. A shadow interest rate - expressed in real (i.e., corrected for inflation) terms - is needed in economic evaluation of projects for two purposes. One is as the discount rate in calculating the net present value of the project (para. 9), or as a yardstick against which the project's internal rate of return can be compared. The second is as an ingredient in calculating certain other shadow prices.

49. The shadow interest rate should reflect the cost to the economy of using investment funds in this project rather than in some other activity. In a country that was willing to borrow and lend abroad freely, this would be the expected rate of interest on the most expensive form of foreign borrowing (usually from commercial banks) deflated by the expected rate of world inflation. China's borrowing, however, is likely to be limited by concern about debt servicing and dependence on foreign creditors; as a result, this external real interest rate will probably be only a lower limit on the shadow interest rate, which will depend primarily on internal economic conditions.

50. Another common approach to estimating the shadow interest rate is to look at actual returns to investment in the country concerned. But this too does not seem appropriate in Chinese circumstances. The average rate of return can be measured only in industry, and even there only at actual Chinese prices - it might be significantly lower at shadow prices. And the
realized rate of return on marginal (i.e., the least attractive) investments, which is in principle more relevant, may be very low—perhaps even negative—as a result of mismanagement, and should not be used as a guide to investment decisions.

51. Instead, the best approach to estimating the shadow interest rate in China is probably (a) to treat consumption as the relevant alternative—or marginal—use of investment funds; and (b) to ask for a national political decision. More specifically, the highest levels of government should in some way be invited to consider the question: what is the minimum acceptable economic rate of return on an investment project, below which it would be preferable for the funds concerned to be used for current consumption? In form, this question may be new. But in substance it is no more than a variation on the familiar question of the proper national ratio of accumulation to consumption. Thus although modifications might be required in the light of experience (especially to ensure consistency with the planned accumulation ratio), it should be possible for political leaders to determine a shadow interest rate that appropriately balances the urgency of raising current living standards against the vital need for rapid growth and higher living standards in the future.

52. In the absence of this sort of political decision on the shadow interest rate, it may be necessary to rely on some rule of thumb. The shadow interest rates used in other developing countries—and by the World Bank

/1 In a socialist economy in which the state mobilizes most of the savings it would probably be inappropriate to base the shadow interest rate directly on the observed saving behavior of households or their responses to changes in interest rates.
Bank - are usually between 10% and 15% per year. In Czechoslovakia and Hungary, the rate is 12% per year.

53. However it is estimated, the shadow interest rate should in principle be applied uniformly to all projects in the economy. To apply a lower rate (a less severe test) in sector A than in sector B, for example, would be inefficient in the sense that the average economic return on investment could be raised by moving funds from A to B. There may be particular reasons for giving preference to projects in one sector or region rather than another - some are discussed in paras. 70-81 below. But experience in other countries suggests that it is better to weigh these factors against their costs in terms of reduced efficiency on an explicit, project-by-project basis, rather than to submerge them in a preferential shadow interest rate.

Nontraded Goods

54. A nontraded good is one whose production or use by a particular project will not affect China's exports or imports of the good concerned, either because transport costs are prohibitive or because of restrictive internal or external trade policies (see paras. 19-22 above). In addition to "natural" nontraded goods such as construction, electricity, internal transport and commerce, most countries are unable or unwilling to trade freely in certain other goods. In China, the proportion of nontraded goods is probably unusually large, as a result of geographical size, limited transport facilities, embargoes by foreign countries, and strong emphasis on local and national self-sufficiency (achieved partly through simultaneous
production of low-quality and high-quality versions of the same goods).\footnote{As mentioned in para. 27, some Chinese manufactured goods are of worse quality than any of their internationally traded counterparts. Such a good should be treated as traded (but with adjustment for quality) if its production or use by a project would have a commensurate effect on the volume of exports or imports of its higher quality counterpart. In other cases, and in particular where low-quality domestic production continues to expand, the output or input concerned should be treated as a separate, nontraded good.}

But the proportion of nontraded goods varies between localities, being larger in provinces further inland.

55. The Shadow Cost Approach. The shadow price of a nontraded input is usually taken to be its shadow cost of production. This is in principle estimated by decomposing its actual cost of production into four elements: traded goods, labor, land, and the services of capital goods (depreciation plus interest and profit). These elements are then revalued at shadow prices established along the lines discussed in earlier sections, and added together to give the total shadow cost. Three aspects of this procedure deserve comment.

(a) More than one round of decomposition may be necessary. For among the production costs of a nontraded good will usually be found not only the four elements mentioned above but also other nontraded goods — including, in China, many capital goods. To shadow price these requires a further round of decomposition, which will turn up yet other nontraded inputs. The sequence is obviously endless, with ever-expanding data requirements. In principle, this problem can be straightforwardly resolved with an (inverted) input-output table: but no satisfactory input-output table is presently available in China; and even in other countries, the relevant tables are
usually too aggregated to permit immediate decomposition of the costs of individual commodities. In practice, therefore, enterprise or industry accounts are the normal basis of the first round of decomposition, which quite often reveals the share of nontraded inputs to be sufficiently small that they can be shadow priced by one of the shortcut methods discussed below without too much fear of error. In other cases, a second round of decomposition, confined to one or two items, may be needed before this stage is reached.

(b) To value the services of a capital good, the simplest approach is to ascertain its operational life and the shadow interest rate, and hence look up (in some standard set of tables /1) the relevant "capital recovery factor" - the fraction of its price that, if paid each year, would exactly cover depreciation and interest. This fraction is applied to the capital good's shadow price to determine the annual shadow capital cost, which can then (in the case of production machinery or a building) be divided by the number of units of output it produces each year, or (in the case of construction equipment) be multiplied by the number of years it is used on the project./2 The shadow cost of working capital per unit of output in an enterprise or industry should similarly be measured by applying the shadow interest rate to the shadow value of the working capital stock and dividing by the number of units of output produced each year.

/1 For example, J.P. Gittinger, Compounding and Discounting Tables for Project Evaluation (World Bank, Washington, 1973).

/2 In practice, it is often necessary to work from data not on individual capital goods but on the value of an aggregate of capital goods. This should if possible be expressed at, or converted to, undepreciated replacement cost rather than depreciated historic cost. It should be shadow priced by multiplication by an appropriate conversion factor. Then the same procedure is followed as with an individual capital good, basing the capital recovery factor on the estimated average life of the capital goods concerned.
(c) In shadow pricing a nontraded good, one should in principle focus not on its average cost of production but on its marginal cost—the resources required to produce one more unit of the good concerned. In practice, this distinction is often neglected for lack of data or time. But there is one situation in which it is particularly important, namely where some input for a project— in China, most commonly a capital good—is being produced by enterprises which for lack of demand are working well below their full capacity. In such a case, one should ignore the capital and other fixed costs of these enterprises, and calculate the shadow cost of the good concerned on the basis only of material, labor and other variable costs.

56. Other Approaches. The shadow cost approach to pricing nontraded goods should not be applied to project inputs which are scarce in the sense that their supply is limited and the cost to the economy of using them exceeds the shadow cost of producing them. In such cases, the shadow price should be based on the loss of other (shadow-priced) output that would result from using the input in the project concerned, which is obviously more difficult to estimate. But since the supply of most manufactured goods can be expanded quite rapidly and many other scarcities can be alleviated through imports, such cases are fairly rare, especially when one looks beyond the short run to the whole life of a project. They tend to arise only: (a) where the input is a nontradable natural resource, such as land; (b) where a produced input is inherently nontradable, the lead time required to expand its production is long, and demand has been seriously underestimated in planning past investments—electricity and transport being possible examples; or (c) where import restrictions are grossly irrational.
57. Perhaps more seriously, the shadow cost approach cannot be applied to nontraded outputs, whose shadow price should be based instead on what they would contribute to national production or consumption (para. 10). It must also be recognized that the shadow valuation of some such outputs, as in the case of road or school projects, cannot be meaningfully approached by the normal route of applying shadow prices to physical quantities of output.

58. The shadow price of a nontraded scarce input or output can sometimes be derived from that of a substitute. For example, the shadow price of natural gas might be based, with suitable adjustment for calorific content, on the shadow price of oil. Or the shadow price of bricks could be based on the shadow prices of steel and concrete, making due allowance for the relative quantities of materials required by the two different methods of construction. Or the shadow price of a locally produced machine could be based, with rough adjustment for differences in performance, on the international price of similar machinery. One should be more cautious about using this approach in China than in other countries, though, since rigid allocative quotas may inhibit these sorts of substitution.

59. In other cases, it may be possible to make a direct, if approximate, assessment of the impact of a nontraded scarce input or output on the shadow value of other production. Irrigation projects, for example, are usually evaluated through assessment of their effects on agricultural output. Road projects also are sometimes evaluated in terms of their contribution to production. In China, moreover, the material allocation

/1 As regards differences in product quality, see also paras. 27 and 54 and their footnotes.
system may make it easier to discover the effects on production of supplying a large new project with a scarce input, as for example where a new allocation of electricity is made by cutting supplies to specified other users. The same general approach may also be used in shadow pricing capital goods. But it is clearly inapplicable to (private and social) consumption goods.

60. In capitalist countries, project evaluators rely to a considerable extent on actual prices in shadow pricing nontraded scarce inputs or outputs - the logic being that the price that users are willing to pay at the margin reflects (if a consumer good) the intensity of need or (if a producer good) how much it would contribute to production. In China, this approach at present seems largely inapplicable, for two main reasons. The first is that most prices are determined administratively rather than by supply and demand, with shortages resolved by rationing or direct allocation: as a result, the actual prices of some goods may understate the urgency of the need to economize on their use or expand their supply. The second reason is that most enterprises and communes are still concerned primarily with meeting or surpassing gross production targets: as a result, they may want to buy more of certain inputs than they would if their main concern was to minimize costs (or maximize profits); and the prices they are willing to pay may exceed the marginal contribution of these inputs to the value of production. Furthermore, even if reform of the system of economic management were to alter the situation in these two respects, the government might still not wish project analysts to place much reliance on actual prices as an indicator of national economic priorities.

/1 If actual prices are used in this way, it is necessary (for reasons explained in the footnote to para. 28) either to work with an exchange rate that equalizes average Chinese prices to average world prices, or, more or less equivalently, to apply suitable general conversion factors to actual prices.
61. In China, however, the problems of shadow pricing nontraded outputs are eased by the existence of medium and long-term plans. These could perhaps serve as a guide in subjectively setting shadow prices for nontraded outputs (relative to the shadow prices of benchmark traded goods) that reflected national priorities. More importantly, such plans can sometimes eliminate the need for shadow valuation of nontraded outputs. The project analyst may simply accept that the planned level of output is necessary, and concentrate on the economic choice between alternative ways of producing it. This cost-minimizing approach is widely used in the West in the evaluation of infrastructure (including electricity generation) and social service projects. It has also been a traditional focus of project evaluation in the Soviet Union and Eastern Europe.

62. **Shortcuts.** In practice, in evaluating a particular project, shadow prices will need to be estimated only for major nontraded inputs and outputs peculiar to the project. For other nontraded goods— and often for all of them— the individual project analyst should make use of standard shadow prices or general conversion factors calculated on the principles outlined above (and periodically revised) by some designated government agency. /1

63. One such standard item is construction. Where a project involves the erection of fairly ordinary buildings or other comparable civil works, their actual renminbi cost should simply be multiplied by a construction

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/1 It is also customary to assume that the shadow prices or conversion factors of nontraded goods remain constant over the project's life. An exception to this rule arises where major increases in efficiency are expected in an industry which supplies an important nontraded input— for example, because the industry is only newly established. In such cases, the expected decline in the shadow cost (and price) of the input concerned should be taken into account.
conversion factor. This in turn should be estimated by the government agency as the average ratio of the shadow cost to the actual cost of a sample of representative buildings in the locality concerned.

64. Another standard item is electricity, for which a shadow price should be calculated in each interconnected grid. This is normally based on the shadow cost of supply from a typical new power plant. A second, lower, shadow price can be estimated for offpeak electricity on the basis of the shadow operating costs (neglecting capital and other fixed costs) of the least efficient plant actually used at offpeak hours. But, if there is an acute scarcity of peak load electricity, as is likely to be the case in most parts of China in the 1980s, its shadow price should (for reasons explained in para. 56) be set above its shadow cost by some plausible margin.

65. A third standard item is internal transport (whose shadow price is relevant, among other things, to calculating the shadow prices of traded goods - para. 23). The usual practice is to calculate separate conversion factors for rail and road transport, both on the basis of shadow cost. Where particular transport facilities are expected to be persistently underutilized, it is appropriate to ignore capital and other fixed costs: in China, this might be relevant to some aspects of road transport, but not in general to the railways, most of which are intensively used. In some cases, indeed, congestion on the railways may have reached the point where (again for the reasons explained in para. 56) the shadow price of rail transport should be set above its shadow cost.
66. A fourth standard item is distribution or commerce. Specifically, it is useful in calculating other shadow prices to have a conversion factor to apply to internal trade margins. This is normally based on shadow cost, taking account of storage, handling and selling expenses, as well as interest on working capital. It should be derived from the accounts of the major organizations concerned with commodity circulation - the Material Supply Bureau and the Ministries of Commerce and Foreign Trade. For each, the ratio of shadow costs to the actual trading margin should be calculated, and the results averaged (unless they turned out to be radically different, in which case one might contemplate the use of different conversion factors for trading margins on different categories of goods).

67. In addition to these standard items, general conversion factors can be estimated for other categories of nontraded goods, especially those which are not traded because of policies of self-sufficiency. Such general conversion factors are useful both in evaluating particular projects and in estimating other shadow prices (for example in decomposing shadow costs - para. 55). In China, one should probably start by estimating at least two general conversion factors for nontraded goods, one for industrial materials and intermediate goods, the other for machinery and equipment. In each category, it might be sufficient initially to estimate a single conversion factor for the whole country, based on ex-factory prices, and establish shadow prices in particular localities by adding differing transport (and trade) margins. Subsequently, it would be desirable to estimate a larger number of general conversion factors, especially for important subcategories of industrial intermediate goods and machinery whose conversion factors are found to differ substantially from the average.
68. These general conversion factors for nontraded goods should usually be estimated as the ratio of shadow cost to actual price, for as representative a sample of items as possible. Ideally, one should work from input-output tables, which provide a fairly simple means of estimating conversion factors for particular sectors or groups of sectors. But in practice in China it would probably be necessary to start either with special studies of important individual items or by drawing on work already done to estimate the shadow prices of particular nontraded goods.

69. In some countries, nontraded goods are shadow priced by applying general conversion factors for the same categories of traded goods, which are usually much easier to calculate (paras. 29-32). Because the ratio of nontraded goods is high, because of quality differences between some Chinese and internationally traded manufactured goods, because the scope for substitution is limited by the material allocation process, and because prices are mainly administratively determined, this approach cannot be generally recommended in China. But it might be acceptable where a project involved nontraded goods (agricultural or manufactured consumer products, say) for which no general conversion factor was available, but which were not important enough to make a special shadow price calculation worthwhile.

Externalities

70. In economic evaluation of a project, one should try to include (and quantify) all benefits and costs to the national economy, even where

/1 See number 12 of the Indian Planning Commission papers referred to in para. 108 of the bibliography. A disadvantage of this method is its reliance on average rather than marginal costs (para. 55).
these do not show up in the accounts of the organization undertaking the project. These financially invisible benefits and costs are called externalities. Some of them have already been mentioned: infrastructure costs (para. 47), congestion of the transport system (para. 65), and the output of non-revenue-generating projects (para. 59). More generally, it is usually vital for purposes of economic analysis to treat groups of projects among which there are important economic linkages (for example, because one supplies the principal input for another) as if they were single projects, and not to evaluate each individual component in isolation.

71. The most important other class of external costs in China is pollution. In some cases, no additional economic calculation is required: this would be so if the government imposed financial penalties on the organization concerned that accurately reflected the damage caused by its pollution, or required as part of the project the installation of special equipment to reduce pollution to a socially acceptable level. In other cases, however, this will not be so; and there will also be rehabilitation and modernization projects whose incidental effects in reducing pollution should be counted as external benefits. But the effects of pollution are difficult to measure in monetary terms. Although there are exceptions (such as well-defined damage to particular crops), the most that can usually be accomplished even in countries with sophisticated environmental protection systems is a description of the various physical consequences of particular amounts and types of pollution.

72. As regards external benefits, the most important category is learning. Specifically, the import or use of new technology in a particular
project may make it easier, cheaper or less risky to use the same technology in subsequent projects, or may indirectly improve technology in other sectors. Obvious ways in which this might happen are through local imitation of imported equipment (which, because Chinese wages are lower, might reduce its price, or, if unlicensed, might avoid royalty payments); and through using staff and workers with training and experience from the first project to teach other people. The knowledge acquired might also improve domestic research and development capability — in Japan, for instance, technology imports have often led to subsequent exports of even better technology.

73. Considerations of this kind have powerfully — and often rightly — influenced project selection in many developing countries. But the benefits of learning are frequently diffuse and protracted, and thus difficult to trace even retrospectively, let alone to quantify in advance. One should also recognize that the learning and teething costs of using new technology in particular projects are sometimes underestimated; that there are instances where, for one reason or another, the spread effects of new technology have been very limited; and that excessive reliance on a single infusion of foreign technology has sometimes had the unfortunate effect of cutting a country off from a continuing process of technical improvement abroad.

74. There is thus no simple and satisfactory way to handle learning externalities in economic evaluation. They should always be considered, and with some projects should be the analyst's main concern. But since it is usually impossible to put a monetary value on them, the best that can be
done in most cases is to describe the potential gains in some detail, including an assessment of the factors that might prevent them from being realized. Where learning effects do not vary much among projects, or among alternative versions of a project, the process of project selection is of course somewhat easier.

Social Evaluation

75. The discussion thus far has been concerned entirely with assessing a project's impact on the economy's total output. But a recent feature of Western project evaluation is to look also at the impact on income distribution, and to give preference to projects which further the government's income distribution objectives. This will be referred to as "social evaluation."

76. The basic principle involved, namely choosing projects partly because they improve the distribution of income between regions or social groups, is of course familiar in China, as in other countries. What is novel about social evaluation is its attempt to be rigorous and systematic - to give a consistent margin of preference to different projects in different places, to make a consistent tradeoff between income distribution and economic efficiency, and hence to make the best use of available resources in pursuing the government's objectives. Social evaluation also considers another dimension of income distribution, namely the balances between saving and consumption and between public and private income, and (in most developing countries) gives preference to projects whose impact would be distributed in such a way as to raise the national saving rate or the share of public sector income.
77. Social evaluation is accomplished by modifying the projected cash flow table (para. 9). Thus, in addition to the sorts of shadow pricing discussed earlier, the project's costs and benefits are weighted to reflect their impact on income distribution. For example, if a project were to add 100 yuan per year to the income of 1,000 poor peasants, one might add 100,000 yuan per year to the flow of benefits - or 200,000 yuan if the peasants were particularly poor or if the government attached especially high priority to raising their incomes. The precise methodology of social evaluation is quite complicated, and will not be addressed here (the bibliography contains several references). What it generates, however, is a modified estimate of the project's economic profitability - higher in the case of a project that contributes to the government's income distribution objectives, lower in the case of one that detracts from them. This modified estimate is then used as a basis for choosing among projects.

78. Some aspects of social evaluation seem of limited relevance to China. First, as regards the balance between saving and consumption, the problem in China (unlike most developing countries) has been that the national saving rate has tended to be too high; and altering the composition of the investment program in favor of projects that raise the incomes of groups with a high propensity to consume is probably not the most effective way to reduce it. Much the same is true of the balance between public and private income, which the government can powerfully influence by adjusting taxes and (actual) prices. Recent budgetary history has of course made clear that some such adjustments are politically difficult, while others could adversely affect production incentives. Nonetheless, it seems likely that in practice, as a method of regulating China's state revenues, tax and price adjustments will be simpler, economically more efficient, and
politically no more difficult than altering the composition of the investment program. Finally, since the means of production are not in private hands and salaries are regulated, there is much less reason than in other countries to be concerned about the distribution of project benefits between rich and middle income groups (although one would want to address the issue of their distribution between foreigners and Chinese people).

79. On the other hand, some aspects of social evaluation do seem relevant to China. By comparison with other developing countries, China has been extraordinarily successful in improving the nutrition, health and education of all its people, and hence in eradicating the worst aspects of poverty. But the incomes of perhaps a quarter of the rural population remain unacceptably low. And it is not possible for the government to raise them sufficiently by direct fiscal redistribution: there is little luxury consumption among other social groups to be squeezed; and direct supplementation of incomes from the budget on more than a very limited scale runs counter to the philosophy of self-reliance. There is thus a strong case for using the composition of the investment program as an instrument for increasing the earning power of the poorest groups and regions. In addition, since urban unemployment is a potentially serious social problem (although the unemployed are protected from acute hardship), labor-intensive projects should perhaps be given higher priority than would appear appropriate on narrowly economic grounds.

80. What is more questionable is whether these objectives should be addressed through formal social evaluation of individual projects. The advantages of doing so, in terms of rigour and consistency, have already been mentioned. But there are also disadvantages. In practice, perhaps the
greatest risk is that the resultant increase in complexity would jeopardize the chances of formal economic evaluation being introduced or used. It may also be argued that in reality no mathematical formulation can be substituted for the political process of balancing the interests of different social groups and localities, and that attempts to do so could cause formal evaluation criteria to be disregarded or improperly manipulated.

81. On balance, in China it would seem advisable to start more modestly. As in World Bank practice, a poverty target group (say, the poorest 200 million people, or the poorest 500 rural counties) could be officially identified and the report on each project could be obliged to state whether it benefits people in this group, and if so how many and how much. Similarly, the report could state the number of jobs created per million yuan of investment (or, equivalently, the amount of investment required to create each job). But this information should probably be presented separately from the formal economic evaluation. At some later date, with formal economic evaluation well-established, a more fully integrated approach could be considered.

Project Selection

82. In appraising a potential investment project, it is necessary to investigate technical, market, financial and administrative, as well as economic and social, aspects. It is also necessary to identify the main alternative variants of the project, in terms of scale, technology, location, timing and so on. The question thus arises of how in practice to select projects on the basis of all this information and analysis.
83. **Economic Profitability.** For each project, and each project variant, shadow prices should be used to calculate such summary measures of economic profitability as the net present value (discounted at the shadow interest rate) and the internal rate of return. If the estimated shadow interest rate could be relied on, and other factors neglected, the criterion for project selection would be straightforward. The best variant of each project would be that with the highest net present value; and all projects with a positive (or more accurately a non-negative) net present value would be undertaken. (A positive net present value implies that the project's internal rate of return - a measure which is often more readily understood by decision makers - exceeds the shadow interest rate. But the internal rate of return should in principle not be used to choose among mutually exclusive alternative variants of a particular project.) Among the advantages of this criterion is that it can be applied to a sequence of projects as they arise, and does not require all the projects in a particular planning period to be chosen simultaneously. It can also permit the project selection process to be efficiently decentralized - although special care is needed where alternative variants of a particular project fall within different regional or sectoral jurisdictions.

84. Three problems sometimes require even this simple criterion for project selection to be modified. One is that the estimated shadow interest rate may turn out to be inconsistent with the planned total amount of

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/1 Mainly since the net present value (and hence the benefit of the economy) of a larger-scale variant with a lower internal rate of return could exceed that of a smaller-scale variant with a higher internal rate of return.
investment, in the sense that the resources that would be required to implement all projects with a positive net present value falls short of or (more commonly) exceeds the investment budget. The second problem is that decentralization of investment decisions is often accomplished by giving lower-level authorities or institutions fixed shares of the aggregate investment budget; hence even if the shadow interest rate is consistent with the aggregate investment budget, lower-level authorities or institutions may find themselves with more or less resources than they would need to undertake all projects with an acceptable net present value. The third problem is that the (aggregate or local) investment budget for the planning period may be rigidly divided into annual installments, which may clash with the economically best distribution of investment expenditures among different years of the planning period.

85. The best solution to the first problem is to revise either the shadow interest rate or the aggregate investment budget; the best solution to the second problem is to make lower-level investment budgets more flexible; the best solution to the third problem is to adjust the annual allocation of the investment budget for the planning period. In practice, however, it may be necessary to modify the simple criterion of accepting or rejecting projects according to whether their net present value are positive or negative. Unfortunately, there is no alternative criterion that is both simple and wholly satisfactory; and Western experts do not all recommend the same second-best solution. But the usual suggestion is that each decision-making unit in each budget period should rank possible new
projects according to their internal rates of return, and should proceed down the list until its budget is exhausted. An obvious disadvantage of this approach is that some decision-making units will reject projects which are more attractive than some of those undertaken by other units, and hence that the best possible allocation of investment resources will not be attained.

86. **Other Economic and Social Considerations.** Matters are further complicated by the fact that economic profitability cannot be the sole criterion for judging the attractiveness of a project (or project variant), and must be informally weighed against other important factors. Two such factors, discussed earlier, are external effects on pollution and learning ( paras. 71-74), and the impact of the project on employment and the incomes of the poor ( paras. 79-81).

87. A third factor is the riskiness of the project. The project should be technically sound, with good administrative arrangements for implementation; and the calculations of economic profitability should be based on the most probable outcome. But many things can go wrong with even

/1 An alternative, and in some respects better, ranking criterion is the ratio of each project’s net present value to its discounted investment cost (or, with equivalent effect, the ratio of its revenues minus its operating costs, all suitably discounted, to its discounted investment cost— which is sometimes called the benefit-cost ratio). There is, incidentally, some disagreement as to whether, in these circumstances, one should still choose among mutually exclusive variants of the same project according to their net present values, or should instead use one of the ratios mentioned in this footnote (or even the internal rate of return).

/2 In doing this, of course, allowance must be made for continuing expenditure on projects started in earlier budget periods, except where new information and analysis indicates that some of these should be abandoned. The usual criterion for abandoning a project would be that the present value of its future (shadow-priced) net cash flow was negative. In making such a calculation and decision, the costs already incurred should be ignored.
a well-planned and well-executed project—bad weather or unanticipated construction problems, a sudden change in world prices, difficulties in mastering a new technology, and so on. These possibilities should be realistically addressed in the course of appraisal, and sensitivity analysis should be undertaken to find out what would happen to economic profitability if some of the more likely difficulties were to arise. If this analysis indicated that the project was very risky, its implementation could be justified only if it was extremely attractive from other points of view.

88. A fourth factor of special importance in China is the project's consistency with the plan and national economic priorities. To a great extent, this is already built into other aspects of the evaluation. Thus the plan should have influenced decisions about whether particular goods will be traded or nontraded (paras. 19-22), and about the shadow valuation of nontraded output (para. 61). Projections of domestic demand and supply should be consistent with the material balances in the plan; and national priorities should shape the assessment of externalities and income distribution effects. Moreover, the flow need not be all one way: the plan itself might to some extent be shaped by economic analysis of particular projects. But in practice the harmony will not be complete, for lack of the necessary time, information or procedures, and hence the conformity of projects with the plan may sometimes be an independent factor in investment decisions.

89. Financial Considerations. Finally, in addition to economic and social factors, it is necessary to consider the project's financial prospects, on the basis of actual rather than shadow prices. In a capitalist country, indeed, this would be crucial, since private investors are more interested in actual profitability than in economic returns. Even in China,
certain sorts of financial analysis are essential, and actual profitability cannot be ignored.

90. To begin with, a project must have a sound financing plan, which specifies the amounts and sources of money to be used for the initial investment in fixed and working capital. If it is to be financed by loans, it must have the capacity to repay those loans, and the interest on them, within an acceptable period. When in operation, it must generate (or be guaranteed from outside sources) sufficient cash to cover both its operating costs and other obligations such as taxes. To prevent temporary cash flow shortfalls from disrupting operations, there must also be a sufficient stock of liquid assets or guaranteed access to a sufficient amount of short-term credit.

91. These, then, are basic financial tests, which every project must pass. In addition, for joint ventures and other projects with foreign participation, it is essential to look closely at the financial viability of any jointly owned enterprise, and to make sure that the distribution of profits and taxes between China and the foreign partners is such as to give China a satisfactory return on investment.

92. Even if there is no foreign participation, the actual profitability of the project to the state may have to be calculated to assist in budgetary and other financial planning. For this purpose, profits should be defined to exclude all amounts retained by the organization undertaking the project, but to include items such as taxes. Insofar as the budgetary process is decentralized, it may be necessary to make separate calculations of the actual profitability of the project to local and central government agencies (and also to the organization undertaking the project).
93. In China, these calculations of profitability at actual prices, though needed for financial planning, should not (except in the case of joint ventures) play a significant role in project selection. This is partly because actual prices give misleading signals (para. 7), and partly because the state has other powerful instruments for raising revenue (para. 78). Thus investment decisions should be made primarily on economic and social grounds; and their consequences for the state budget should be offset by suitable adjustment of taxes or actual prices.

94. In practice, of course, investment decisions in China are to some degree influenced by actual profitability, especially when they are made by communes or enterprises which retain part of their profits or by local governments which retain a share of the revenue they collect. Such financial incentives are, from other points of view, very desirable. But it is important to ensure that they do not lead to bad investment decisions. Thus all projects should be required to pass appropriate tests of economic attractiveness, which should include having a positive net present value - and being the most attractive variant - at shadow prices. In addition, funds should be made available from other sources to implement economically attractive projects which profit-seeking units are unable or unwilling to finance. It might also be possible to base incentives on profits calculated at shadow rather than actual prices.

95. Distorted financial incentives are of course not the only enemy of good project selection. In every country, bad investment decisions also result from bureaucratic confusion and empire-building, political favoritism and horse-trading, the desire for projects as personal or organizational monuments, and misguided enthusiasm for all ultramodern technology.
Thorough and open appraisal, including systematic economic evaluation, is a good weapon against these enemies. But there is no magic formula for good investment decisions. Dispassionate appraisal can prevent many serious errors; yet judgment remains essential in weighing different criteria against one another.

**Economic Evaluation in Practice**

96. The methods for estimating shadow prices described in earlier sections of this paper may seem daunting in their demands on both data and time. But it is not necessary or desirable to go through each of the steps with equal thoroughness for every project. Even if unlimited time were available, the analysis should not be refined to the point where the costs of achieving greater accuracy in the estimate of economic profitability outweigh the likely benefits. And since in practice time and manpower are limited, it is often necessary to stop well short of this point. This does not render the analysis worthless: on the contrary, a rough or incomplete economic evaluation is usually much better than nothing at all. But it places a premium on making the best use of available time and manpower.

97. One obvious guideline is to allocate analytical resources in proportion to the size of projects. Big projects should be evaluated more carefully than small ones — some of which may have to be neglected altogether. Greater care should also be taken with types of projects where past experience or prior judgement suggests that proper economic evaluation is particularly likely to affect the investment decision — for example where the actual prices of major inputs and outputs are known to diverge substantially from world prices.
98. Similarly, within each project the analyst should allot his time in proportion to the magnitude of inputs and outputs, using the great majority of it for shadow pricing a few major items. Minor items should be dealt with more cursorily, since even leaving them at their actual prices would introduce a relatively small error. Likewise, among items of similar magnitude, priority should be given to those whose shadow prices are suspected to diverge most substantially from their actual prices.

99. In different sectors, different sorts of simplification are appropriate. With most industrial projects, for example, shadow pricing of labor and land is not crucial. In agriculture and some infrastructure projects, by contrast, labor may be an important component of project costs, and greater care is needed in estimating the shadow wage. On the other hand, learning externalities are usually less important in agriculture, while in infrastructure it may not be necessary to estimate the shadow value of project output (para. 61).

100. But in all sectors, in applying Western methods of economic evaluation, the shadow pricing of traded goods is of central importance, simply because (as explained in paras. 12-17), world prices are used as a basic point of reference. Accurate shadow pricing of other project outputs and inputs - which in some cases indirectly involves world prices - is usually less crucial, which is fortunate, because it is generally more difficult and time-consuming. One should not, however, underestimate the difficulty of obtaining and interpreting data on world prices, especially if it is necessary to make adjustments for quality or to forecast future trends.
101. As mentioned at various points above, the individual project analyst should be provided with certain standard shadow prices and conversion factors by some relevant (local or central) government agency; he should also be able to find out about the shadow prices estimated for particular commodities by other project analysts. This not only saves a lot of time; it also helps to ensure that different projects are evaluated on a consistent basis. To begin with, the standard shadow prices and conversion factors are bound to be rough estimates. But they will be better than nothing, and can be improved and updated on the basis of subsequent research and experience. More generally, periodic review and revision by relevant central government agencies of the procedures and assumptions being used in economic evaluation of projects is very important.

102. Though the methods of economic evaluation described in this paper try to make the maximum possible use of objective information in a consistent and unified framework, much depends on the common sense, judgement and ingenuity of the person doing the work. Few of the procedures for estimating shadow prices are completely unambiguous; no project is exactly like any other project; and all information should be critically reviewed. It would thus be a mistake to treat economic evaluation as a mechanical process. Instead, one should emphasize the basic principles involved, and the need to apply them flexibly and intelligently.

103. It would also be wrong to suggest that the methods of economic evaluation described in this paper are ideal, or always give correct results. Among other things, project appraisal inherently involves forecasting the future, and some mistakes are accordingly inevitable. It is simply that good project appraisal, of which calculations of economic
profitability are an important part, reduces the proportion of mistakes - both the obvious ones and those more subtle but more numerous cases where superficially successful projects are uneconomic, or where mediocre projects displace really good ones. The object of economic evaluation, moreover, is not merely to raise the average return on investment, but to make better use of all resources, physical and human. At modest cost, it can thus contribute to faster economic growth and higher living standards.

Bibliography

104. The annotated list below is only a small fraction of the literature on economic evaluation of investment projects - although many of the books on the list contain larger bibliographies. The reader should also be warned that there is not one Western method of economic evaluation, but a family of related methods. The basic principles involved are the same. But a number of more minor differences can cause confusion.

   (a) Terminology varies somewhat. What have been called shadow prices in this paper are sometimes called accounting prices or adjusted prices, while the shadow interest rate is sometimes referred to as the social discount rate or the opportunity cost of capital. What are called adjusted world prices in this paper are often called border prices. What this paper calls economic analysis is labelled efficiency analysis (or traditional analysis) by authors who use the term economic analysis to cover also what this paper calls social evaluation.
(b) Similarly, algebraic treatment is not standardized. Different authors apply different symbols to the same concepts, and equivalent algebraic formulae are sometimes presented differently.

(c) There is also a celebrated difference between what is called the Little-Mirrlees (or OECD) approach and what is called the UNIDO approach. The present paper corresponds more closely to the Little-Mirrlees approach, which is framed in terms of conversion factors. The UNIDO approach, by contrast, is framed in terms of a shadow exchange rate (see footnote to para. 28). In circumstances when it is appropriate to use only one general conversion factor, this difference is purely one of form. However, when many conversion factors are needed, as is the case in China, the difference becomes one of substance. There are a few other substantive differences (discussed on pp. 358-362 of the book by Little and Mirrlees listed below). But the two approaches also have a lot in common.

(d) The present paper presents economic evaluation and social evaluation separately, with much less emphasis on the latter. Many of the works listed below, however, provide a unified treatment of economic and social evaluation — and some give disproportionate emphasis to social evaluation (mainly because this is less familiar to Western readers). Unified treatment has some advantages, and might be essential if wide use of social evaluation were contemplated. But it makes for very much harder reading; and it is not at all easy for the inexperienced reader who is interested mainly in the economic aspects of project evaluation to disentangle them from the social aspects.
(e) Even within economic evaluation, many of these books and articles give a misleading impression of practical priorities and problems. The shadow pricing of traded goods is usually discussed very briefly, with most of the space devoted to the complexities of other sorts of shadow pricing. Yet it is the application of world prices to traded goods which is the most fundamental aspect of Western economic evaluation. Moreover, to obtain and correctly apply world price data is not always simple, but often requires considerable time, persistence, and skill. Indeed, the economic analysis that is needed to estimate and project many world prices frequently gives vital insights into the economic viability of the project concerned, which the analyst's subsequent formal calculations serve mainly to check and refine.

(f) In addition, different authors advocate somewhat differing procedures for estimating particular shadow prices and suggest somewhat differing solutions to other practical problems. One important cause of these variations is the differing circumstances of the countries with which the authors have been involved. Thus most Western authors have in mind as their model of a developing country one that is fairly small, engages extensively in foreign trade, has a large private sector, and allows most prices to be determined by market forces. The contents of the present paper, however, have been shaped by the radically different situation of China. Hence, for example, the use of actual prices as a guide to shadow prices has been de-emphasized, while special emphasis has been given to the shadow valuation of nontraded goods. (In combination, these two factors somewhat reduce the applicability of Western methods of economic evaluation, and correspondingly enhance the role of the plan - para. 61.)

106. Another relevant book, which has recently been made available in Chinese, is UNIDO’s Manual for Evaluation of Industrial Projects (United Nations, New York, 1980), prepared in collaboration with the Industrial Development Center for Arab States. It argues persuasively against integrating social and economic evaluation; but its recommendations on economic evaluation are not clearly expressed. In Chapter I, it appears to reject shadow pricing, and to recommend the use of value added (profit plus wages) rather than profit as a measure of economic attractiveness. In
Chapter II, however, it argues that actual prices should be adjusted for purposes of project evaluation, and more specifically that traded inputs and outputs should be valued at world prices; it also argues that one should reject projects whose value added at adjusted prices is insufficient to cover wages (i.e. whose profits are negative). Some of the differences between this Manual and the present paper are thus a matter of words rather than substance. Similarly, the Manual's recommendation that actual rather than shadow wages be used in evaluating industrial projects is consistent with the present paper (para. 39). But there is one real difference: this Manual, like other UNIDO publications, recommends that nontraded outputs and inputs should usually be valued at actual domestic prices, with an adjusted (or shadow) exchange rate being used to convert foreign into domestic currency; the present paper, by contrast, argues (paras. 7, 60) that this is not appropriate in China, where few actual prices are determined on the basis of market forces or other economic criteria.

107. Two good books on nonindustrial projects are J.P. Gittinger, *Economic Analysis of Agricultural Projects* (World Bank, Washington, 1972) and H.A. Adler, *Economic Appraisal of Transport Projects* (Indiana University Press, 1971). Parts of both books are available in Chinese from the World Bank's Economic Development Institute, as are a number of other comparatively simple papers on economic evaluation, including: I.A. Sirken, "Cost-Benefit Analysis -- Techniques, Uses and Limitations" (which discusses education projects); four chapters of F.L.C.H. Helmers, "A Primer on Industrial Project Evaluation", with separate papers by the same author on "Cost-Benefit Analysis and Decision-Making" and "Project Planning, Pricing and Productivity in a Socialist Economy"; and various case studies. On financial analysis and other aspects of project evaluation, several
papers in Chinese are available from the same source, including: "Teaching Program in Basic Finance", Parts I and II; F.H. Lamson-Scribner and N.R. Burnett, "Time Value of Money"; and P.O. Malone, "Sensitivity Analysis". These should be read in conjunction with the UNIDO Manual for the Preparation of Industrial Feasibility Studies (United Nations, New York, 1978), which is available in Chinese and covers most aspects of project evaluation other than economic evaluation.

108. Standard shadow prices and general conversion factors have been estimated for many developing countries; some of the estimates are referred to in the works already cited. Of special relevance to China is research undertaken in India, another large country with a relatively small foreign trade sector, whose results were reported in a series of technical working papers published by the Project Appraisal Division of the Indian Planning Commission, mainly in 1974. Among the more important papers in this series are number 1 on long-run border prices, number 2 on transportation, number 3 on internal trade margins, number 5 on divergences between the domestic and international prices of traded goods, number 7 on electricity, number 9 on unemployment and surplus labor, number 12 on nontraded goods, and number 13 on conversion factors for agricultural output. Most of the results are summarized, more accessibly, in D. Lal, Prices for Planning (Heineman, London, 1980).

109. It is also illuminating to see how economic evaluation has been applied to particular projects, including the practical shortcuts used. In addition to those available from the World Bank's Economic Development Institute, project case studies are referred to in many of the works cited above, and several others are contained in I.M.D. Little and M. Scott (eds.),
Using Shadow Prices (Heinemann, London, 1976). An application to China of the methods described in the present paper is S. Ichishima and A. Wood, "Economic Analysis of Aluminum Milling in Shanghai" (May 1982, available in English and Chinese from the World Bank's Economic Development Institute and from the China Investment Bank). The Staff Appraisal Reports on World Bank projects, which are made available to all member governments, also constitute a rich store of examples of practical economic analysis.

110. The literature on project evaluation in the Soviet Union and Eastern Europe is smaller. In the Soviet Union itself, despite efforts at reform, project evaluation criteria have apparently not changed much in recent years: rather unsatisfactory formulae are used to assess the least-cost methods of producing the outputs specified independently by the plan; and there is little or no application of shadow prices. But a considerable amount has been published on the theory of investment choice, including shadow prices and their relationship to linear programming and other modern planning techniques, as well as to the law of value, production prices and other principles of socialist economics. This has contributed to changes in investment criteria in several East European countries: discounted cash flow formulae (identical or equivalent to those used in the West) are applied to determine not merely least-cost methods but also whether or not certain outputs should be produced; and world prices are extensively used as shadow prices. Several relevant articles are contained in A. Nove and D.M. Nuti (editors), Socialist Economics (Penguin Books, London, 1972): see especially those by Kalecki and Rakowski, Nove, and Nuti, as well as that by V.V. Novozhilov, who has also published a book entitled Problems of Cost-Benefit Analysis in Optimal Planning (M.E. Sharpe, New York, 1970). Current Hungarian practice is discussed in P. Hare, H. Radice and N. Swain
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