Applications of the Policy Analysis Matrix in Indonesian Agriculture

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Applications of the Policy Analysis Matrix in Indonesian Agriculture

Introduction

The Indonesian Government is constantly searching for ways to make Indonesia’s agriculture more productive. If greater output could be produced with the country’s land, labor, and other scarce resources, Indonesia could grow more food and raise rural incomes. How can analysts, at both central and local levels, best evaluate proposed agricultural projects and policies to see if they would increase productivity?

This book is written for Indonesian policy analysts and policy makers, especially those who work outside of Jakarta, and for students and practitioners of agricultural policy in Indonesian universities. The purpose is to introduce a method of economic analysis to evaluate public investment projects and public policies in the agricultural sector. An approach called the Policy Analysis Matrix (PAM) is proposed to serve that purpose. The unique feature of the PAM method is its flexibility. It can be used for both project and policy analysis.

The PAM approach is more than two decades old, and much has already been written to explain its theoretical foundations and demonstrate its use. The method also has been used widely to analyze Indonesian agricultural issues. In this book, the authors hope to explain the conceptual essence of the PAM method, give practitioners practical exercises in applying the approach, and provide recent case studies of PAM analysis in Indonesian agriculture. The goal is to make the PAM method easily accessible for wide use in Indonesia.

Part One contains an integrated discussion of theoretical concepts and empirical procedures. The authors firmly believe that the best way to understand an analytical approach is to try it out. But learning-by-doing can only be successful if the analyst travels two parallel paths – understanding economic principles and applying practical concepts. Learning through classes, books, and computer tutorials needs to be accompanied by experience in the field and in the policy maker’s office. Part One of this book, therefore, is both conceptual and empirical. It shows why specific types of information are needed for project and policy analysis and how to go about finding that information in Indonesia.

The second section of the book, Part Two, is a collection of case studies. Busy policy analysts often can appreciate the value of an analytic approach most easily if they see examples of its application. The illustrations can be especially persuasive if they contain timely analysis of

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1 The Policy Analysis Matrix (PAM) introduced in this chapter has been described and applied widely in the literature on agricultural development. A concise summary can be found in Eric A. Monke and Scott R. Pearson, The Policy Analysis Matrix for Agricultural Development (hereafter PAM), 1989, Chapter 13, pp. 261-265. The PAM book also addresses each dimension of the approach in detail in earlier chapters. The PAM approach was first developed in 1981 by researchers at the University of Arizona and Stanford University to study changes in agricultural policies and projects in Portugal. The seminal book applying this analytical approach is Scott R. Pearson et al., Portuguese Agriculture in Transition, 1987.

2 An empirical application of this framework to rice in Indonesia is found in Scott Pearson et al., Rice Policy in Indonesia (hereafter RPI), 1991, Chapter 4, pp. 38-58 and Chapter 7, pp. 114-120, 131-137.
recent agricultural issues in various regions of Indonesia. The studies summarized in Part Two are all drawn from work carried out under the Food Policy Support Activity, a collaborative program involving BAPPENAS, the United States Agency for International Development (USAID), Development Alternative, Inc. (DAI), The Ministry of Agriculture, and faculty from more than forty universities in Indonesia. These case studies illustrate well how the PAM approach can be applied fruitfully to a wide range of project and policy issues in rural Indonesia. Topics to which the PAM methodology described in Part One has been applied include rice, soybeans, potatoes, cloves, cashews, shrimp, and broilers. Repeated interactions with FPSA staff have produced papers whose results provide interesting views on such current policy debates as the comparative advantage of rice and the desirability of subsidizing soybeans.

Part Three consists of an overview of the lessons learned from the Outreach Project’s research activities. Although there was a good deal of variability in the skill with which the research projects were carried out, most researchers had difficulty with one or more problems associated with their empirical work. Part Three focuses on the most frequently encountered issues and reviews the appropriate procedures for resolving them. The section emphasizes the importance of thinking through carefully the commodity system being studied in order to be sure that the study incorporates all the material needed to answer the policy issues being addressed.

The book also contains an associated computer tutorial covering the materials discussed in Part One. The authors have much experience in teaching short courses and workshops in Indonesia and in many other developing countries. With the introduction of inexpensive microcomputers, computer tutorials have become an integral part of successful teaching of agricultural policy analysis. Since most Indonesian analysts and university teachers and students now have easy access to computers, computer tutorials have become a feasible and popular means of complementing and deepening written instruction. The focus of the tutorial is on how to carry out the basic PAM method and important extensions of it. Most students can understand concepts better and learn them more quickly if they combine reading with practice.
PART ONE: THEORETICAL CONCEPTS AND EMPIRICAL PROCEDURES

Chapter 1: A Framework for Agricultural Policy Analysis

Everyone involved in agricultural policy and project analysis should have a clear way of thinking about evaluating decisions. On what grounds can one alternative be judged better than another? How much policy is enough? Is economic efficiency the only thing that matters? For rational decision-making to take place, each of us needs a clear and logical way to evaluate policy options. In an ideal setting, everyone would have a similar way of approaching policy decisions. Then disagreements would be limited to genuine differences of opinion rather than including also misunderstandings about approaches to problem solving. This chapter sets out a general logical approach for carrying out agricultural policy analysis. The specifics of the Policy Analysis Matrix (PAM) then are introduced in succeeding chapters.

A well-understood framework for agricultural policy analysis is needed for decision-makers and interest groups to understand the consequences of policy actions. The clarity of definitions is critical in policy analysis. What is meant by the term, “framework for agricultural policy analysis?” A framework is an organized and consistent approach for clear thinking. Without it, policy debate can quickly reduce to misunderstanding and emotionalism. A framework is designed to permit the study of linkages in economic systems. Good economic analysis is fascinating for economists, frustrating for non-economists, and relevant for everyone because it focuses on linkages within an economy – on why one group’s actions influence others in the system. Agricultural refers to the production and consumption of commodities that are produced by cultivating crops or raising livestock. Policies are government actions intended to change behavior of producers and consumers. Analysis consists of the evaluation of government decisions to change economic behavior. A framework for agricultural policy analysis, therefore, is a logical system for analyzing public policies affecting producers, marketers, and consumers of crops and livestock products.

Four Components of a Policy Framework

The four central components in the framework for agricultural policy analysis proposed in this book are objectives, constraints, policies, and strategies. Objectives are the desired goals of economic policy as defined by the policy makers. Government officials wish to achieve certain ends when they intervene in economies. Constraints are the economic realities that limit what can be accomplished. If land is used to grow rice, it is not available to produce an alternative crop in that production season. Policies are the instruments that governments can use to change economic outcomes. Effective policies change the behavior of producers, marketers, and consumers and create new economic outcomes. Strategies are the sets of policy instruments that government officials can use to achieve their objectives. Each strategy is enacted through the introduction of a coordinated set of policies.

3 The framework for agricultural policy analysis developed in this book has been described in the literature on agricultural development. The seminal article elaborating this kind of analytical framework is C. Peter Timmer, “The Political Economy of Rice in Asia: A Methodological Introduction,” Food Research Institute Studies 14, No. 3 (1975), pp. 191-196.

4 These four components are discussed in PAM, Chapter 13, pp. 255-257.
The policy framework, portrayed in Figure 1.1, is represented by a circular (clockwise) set of causal linkages among the four components. The strategies of policy makers consist of sets of policies that are intended to improve economic outcomes (as judged by the policy makers). The selected policies work through the constraints set by economic parameters. The constraints, set by supply, demand, and world price conditions, either further or impede the attainment of objectives. An assessment of the impact on objectives permits an evaluation of the appropriateness of given strategies. Governments thus form agricultural strategies by choosing a set of policies to further their objectives subject to the constraints on the agricultural economy. With this logical picture in mind, it is important to review each of the four components in more detail.

**Figure 1.1. Graphic Representation of a Policy Framework**

![Diagram showing the relationship between strategies, policies, objectives, and constraints]

**Fundamental Objectives of Policy Analysis**

Most goals of government policy fall under one of three fundamental objectives – efficiency, equity, or security. Efficiency is achieved when the allocation of scarce resources in an economy produces the maximum amount of income and the allocation of goods and services brings highest consumer satisfaction. Equity refers to the distribution of income among groups or regions that are targeted by policy makers. Typically, greater equity is achieved by more even distribution of income. However, because policy refers to government actions, the policy makers (and indirectly voters in a democracy) define equity. Security is furthered when political and economic stability allows producers and consumers to minimize adjustment costs. Food security refers to the availability of food supplies at affordable and stable prices. In this framework, any goal that a policymaker is hoping achieve through government intervention will be incorporated within one of the three fundamental objectives – efficiency, equity, and security.
Trade-offs arise when one objective can be furthered only if another is impeded – that is, when gains for one goal result in losses for another. When trade-offs exist, policymakers have to place weights on the conflicted objectives – by determining how much they value gains from one objective versus losses associated with a second objective. Policy makers – not economic analysts – have the responsibility to make these value judgments and assign weights to objectives. These government officials have the ultimate responsibility to be accountable for their policy actions. In the rare instances when trade-offs do not arise, policy analysis and policy making are easy. The desired result is to move forward to the extent that resources permit. Typically, however, trade-offs do exist. Then economic analysts need to evaluate policies, and policy makers need to make decisions by placing weights on objectives. The weights have to add to one (e.g., an individual policy maker might place weights of 0.6 on efficiency, 0.3 on equity, and 0.1 on security).

**Constraints That Limit Agricultural Policy**

The scope for agricultural policy is defined by three basic constraints – supply, demand, and world prices. Supply, national production, is limited by the availability of resources (land, labor, and capital), technologies, relative input prices, and management capabilities. These parameters are the components of production functions and thus limit the ability of the economy to produce agricultural commodities. Demand, national consumption, is limited by population, income, tastes, and relative output prices. These parameters are the components of demand functions and thus limit the ability of the economy to consume agricultural products.

World prices, for internationally tradable outputs and inputs, define and limit the opportunities to import to increase domestic supply and to export to increase markets for domestic production. These three economic parameters define the market for an agricultural commodity and are the fundamental forces that influence price formation and the allocation of resources. The economic constraints lead to trade-offs in policy making.

**Categories of Policies Affecting Agriculture**

Policies influencing the agricultural sector fall into one of three categories – agricultural price policies, macro-economic policies, or public investment policies. Agricultural price policies are commodity specific. Each price policy targets only one commodity (e.g., rice) at a time. Price policies also can influence agricultural inputs. Macro-economic policies are nationwide in coverage. Macro policies thus affect all commodities simultaneously. Public investment policies allocate capital expenditures from the public budget. They can affect various agricultural groups – producers, traders, and consumers – differently because they are specific to the areas where the investment occurs.

**Agricultural Price Policy Instruments**

All agricultural price policy instruments create transfers either to or from the producers or consumers of the affected commodity and the government budget. Some price policies affect only two of these three groups, whereas other instruments affect all three groups. In all instances, at least one group loses and at least one other group benefits. Policy analysts need to consider three categories of agricultural rice policy instruments – taxes and subsidies, international trade restrictions, and direct controls.
Taxes and subsidies on agricultural commodities result in transfers between the public budget and producers and consumers. Taxes transfer resources to the government, whereas subsidies transfer resources away from the government. For example, a direct production subsidy transfers resources from the government budget to agricultural producers.

International trade restrictions are taxes or quotas that limit either imports or exports. By restricting trade, these price policy instruments change domestic price levels. Import restrictions raise domestic prices above comparable world prices, whereas export restrictions lower domestic prices beneath comparable world prices.

Direct controls are government regulations of prices, marketing margins, or cropping choices. Typically, direct controls must be accompanied by trade restrictions or taxes/subsidies to be effective. Otherwise, “black markets” of illegal trade render the direct controls ineffective. Occasionally, some governments have sufficient police power to enforce direct controls in the absence of accompanying trade regulations. Direct controls of cropping choices can be enforced, for example, if the government allocates irrigation water or purchased inputs.

**Macro-economic Policies Affecting Agriculture.**

Agricultural producers and consumers are heavily influenced by macro-economic polices even though they often have little influence over the setting of these nation-wide policies. Three categories of macro-economic policies – monetary and fiscal policies, foreign exchange rate policies, and factor price, natural resource, and land use policies – affect agriculture.\(^5\)

Monetary and fiscal policies are the core of macro-economic policy because together they influence the level of economic activity and the rate of price inflation in the national economy, as measured by increases in indexes of consumer or producer prices. Monetary policies refer to controls over the rate of increase in the country’s supply of money and hence the aggregate demand in the economy. If the supply of money is increased faster than the growth of aggregate goods and services, inflationary pressure ensues. Fiscal policies refer to the balance between the government taxing policies that raise government revenue and the public expenditure policies that use that revenue. When government spending exceeds revenue, the government runs a fiscal deficit. That result creates inflation if the government covers the deficit by expanding the money supply.

Foreign exchange rate policies directly affect agricultural prices and costs. The foreign exchange rate is the conversion ratio at which domestic currency exchanges for foreign currency. Most agricultural commodities are traded internationally, and most countries either import or export a portion of their agricultural demand or supply. For internationally tradable commodities, the world price sets the domestic price in the absence of trade restrictions. The exchange rate thus directly influences the price of an agricultural commodity because the domestic price (in local currency) of a tradable commodity is equal to the world price (in foreign currency) times the exchange rate (the ratio of domestic to foreign currency).

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Factor price policies directly affect agricultural costs of production. The primary factors of production are land, labor, and capital. Land and labor costs typically make up a substantial portion of the costs of producing most agricultural commodities in developing countries. Governments often enact macro policies that affect land rental rates, wage rates, or interest rates throughout the economy. Other factor price policies, such as minimum wage floors or interest rate ceilings, influence some sectors more than others. Some governments introduce special policies to attempt to control land uses or to govern the exploitation of natural resources, such as minerals or water. These macro policies can also influence the costs of agricultural production.

**Public Investment Policies Influencing Agriculture.**

The third category of policies affecting agriculture includes public investments from the country’s capital budget – in infrastructure, human capital, and research and technology. Public investments in infrastructure can raise returns to agricultural producers or lower agricultural costs of production. Infrastructure refers to essential capital assets, such as roads, ports, and irrigation networks, which would be underprovided by the private sector. These assets are known as “public goods,” and they require public spending from the government’s capital budget. Investments in infrastructure are by nature particular to specific regions and benefit mostly the producers and consumers who live in those regions. Public investment policy is complicated by the fact that infrastructure must be maintained and renewed.

Public investments in human capital include a wide range of spending from the government’s capital budget to improve the skill levels and health of agricultural producers and consumers. Investments in formal schools, training and extension centers, public health facilities, human nutrition education, and clinics and hospitals are examples of public capital spending that could raise the level of human capital in the agricultural sector. These investments are critical for long-term development, but they often take many years to show dividends in agriculture.

Public investments in research and technology are another example of “public goods” that directly benefit agricultural producers and consumers. Countries that enjoy rapid agricultural growth typically invest heavily in agricultural research to breed or adapt high-yielding varieties of food and cash crops developed in international research centers abroad. These “miracle seeds” often require new agricultural production technologies, utilizing better water control and more intensive application of purchased inputs. For some commodities, the technological breakthroughs, funded by public investment, are in agricultural processing rather than in farming.

**Application of the Framework to Past Rice Policy in Indonesia**

A study done by the Food Research Institute, Stanford University in the late 1980s provides an illustration of applying the framework for agricultural policy analysis. The framework included rice strategy targets (“strategies”), rice policy instruments (“policies”), principal economic variables (“constraints”), and fundamental food policy objectives (“objectives”). Figure 1.2 is drawn from that study.

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6 *RPI*, pp. 2-6
The rice strategy targets consisted of three alternatives. One was to strive for regular exports of rice by attempting to achieve an annual growth rate for rice production of 4 percent. Another was to aim for regular imports of rice by expanding rice production at an annual rate of 1 percent. The third was to hope for an annual growth rate of rice output of 2.5 percent to retain self-sufficiency in rice production on trend (by importing some rice in poor production years and exporting some rice in good production years). The study assessed the likely impact of each of these three strategies.

The *RPI* book assessed the reasons for Indonesia’s success during the Green Revolution period of the 1970s and 1980s. During that period, Indonesia evolved from being the largest importer of rice in the world to achieving rice self-sufficiency on trend for a decade beginning in 1984. Among the five available types of rice policy instruments, government decisions in four areas were essential for success.

Price policy instruments altered the level of domestic rice prices. Price stabilization policies reduced the fluctuation of domestic rice prices. Public investments, especially in infrastructure and research, affected prices, costs, and yields of rice production systems. Macroeconomic policies, notably those affecting inflation and the exchange rate, influenced rice production costs and the value of the rice produced. But rural regulations impeded some rice farmers’ ability to plant rice.

Rice price level policy was neutral. The government desired to have efficient rice expansion so it kept domestic rice prices close to the trend of world rice prices, providing neither

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7 *RPI*, pp. 8-21
protection nor disprotection to rice production. However, to encourage farmers to adopt the new 
technologies featuring high-yielding varieties of rice seeds, the government heavily subsidized 
chemical fertilizers during this period, thereby reducing costs of rice production.

Rice price stabilization policy was very positive. The National Logistics Agency, 
BULOG, stabilized domestic rice prices so that domestic rice price fluctuations were 
considerably less than world rice price fluctuations. BULOG had a monopoly on international 
trade in rice and varied imports or exports to meet domestic needs. The agency maintained a 
public buffer stock in rice by buying paddy at a guaranteed floor price and injecting the milled 
rice into the markets when prices rose. This stabilization policy was expensive but largely 
successful.

Public investment policy in rural infrastructure, health and education facilities, and 
agricultural research and extension was a key component of Indonesia’s success in tripling rice 
yields and production and thus in achieving temporary rice self-sufficiency. The government 
invested heavily in rural roads, ports, and irrigation facilities and for a period devoted as much as 
30 percent of its capital budget to rural infrastructure and agricultural research.

Macro-economic policies during the 1970s and 1980s were appropriately neutral. The 
annual rate of inflation typically was held beneath 10 percent, and the exchange rate was 
devalued periodically to offset the difference between inflation rates in Indonesia and those of its 
main trading partners. Rice producers thus were neither implicitly taxed nor subsidized by 
longstanding disequilibrium exchange rates, and they could count on quite stable macro-
economic conditions in planning their investments and annual production inputs.

Rural regulations were the only negative area of policy affecting rice production in the 
1970s and 1980s. In parts of East and Central Java, many farmers were forced by a policy 
decision to grow sugarcane when they preferred to plant rice. This decision led to less rice 
production, lower farmer incomes, and less employment relative to levels that would have been 
created under a free choice of cropping patterns.

These policy instruments affected levels of rice production through their influence on 
three principal economic variables – the amount of rice produced domestically, the level of rural 
income that was generated directly in rice production or indirectly from the investment or 
consumption of rice-related incomes, and the level of rural employment created directly or 
indirectly by rice production. Each of these three variables in turn influenced the three 
fundamental food policy objectives. Regular increases in domestic rice output contributed to 
food security and price stability by reducing exposure to world price fluctuations. The efficient 
generation of income through rice expansion led to rapid income growth regionally and 
nationally. The creation of additional rural jobs, directly in rice production or indirectly in rice-
related activities, improved the distribution of income between urban and rural areas.

The RPI book concluded that the strategy of trend self-sufficiency was likely to be the 
one preferred by policy makers in the early 1990s. An effort to achieve regular rice exports

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8 RPI, pp. 162-169
would have been inefficient and required regular subsidies, whereas a strategy to import regularly in the early 1990s would have left efficient production opportunities unrealized.

**Analysis of Current Rice Policies in Indonesia**

Current rice price policy in Indonesia attempts to raise domestic rice prices to levels about 30 percent higher than they would be if they were instead set wholly by rice import prices. The strategy is to assist rice producers during a period when world rice prices are low, about one-fourth less than their expected long-run trend levels. However, this strategy prevents Indonesian consumers of rice from benefiting from the low world prices and thus has adverse impacts on human nutrition and poverty alleviation.

The policy instrument used to implement this strategy is a specific tariff on rice imports of Rupiah 430/kilogram. If this tariff were collected on all imports of rice, the policy would raise domestic prices to levels about 30 percent higher than they would be in the absence of policy. Recent observed levels of domestic rice prices in Indonesia have been about 25-30 percent higher than comparable import prices of rice. However, this outcome does not mean that the tariff is being collected fully and that smuggling is absent. The highly uncertain economic and political environment in Indonesia has caused rice importers to charge a premium of perhaps 10-20 percent to cover the risks of exchange rate changes and the costs of extra banking charges.

The policy of protecting rice furthers the goal of increasing rice farmers’ income within the broader equity objective. However, the policy leads to important trade-offs because it penalizes poor rural and urban consumers of rice. The tariff does not improve economic efficiency because it causes scarce resources to be used inefficiently. In an era of low and relatively stable world rice prices, the rice tariff does little to contribute to food security. Raising the price of rice also has serious consequences for the nutrition of poor people, and it creates additional poverty by pushing more poor families beneath the poverty line.

In principle, the government could assist rice farmers by using a different price policy instrument – a direct production subsidy through which farmers would receive a government subsidy according to the amounts of rice marketed. This policy would avoid raising the domestic price of rice and thus would eliminate the trade-offs between producers and consumers. However, the subsidy policy would be difficult to implement and it would put great pressure on the government budget during a time of fiscal stringency. Some analysts argue that scarce government resources instead should be used to assist rice farmers to switch gradually to higher valued commodities.

**Impact of Current Rice Policies on Objectives**

In contrast to the rice policy during the Green Revolution period of the 1970s and 1980s, current rice policy in Indonesia has not been very successful. Rice policy has floundered since the mid-1990s and especially since the macro-economic crisis began in mid-1997.

The appropriateness and effectiveness of the policy to raise rice prices has been hotly debated. The specific tariff of Rupiah 430/kilogram of rice and the rice traders’ risk premium have together raised domestic rice price levels about 25-30 percent above comparable import
prices. Many government officials appear to feel that the gain to rice producers offsets the loss for rice consumers and the poor, but the issue is under frequent review.

Price stabilization policy has fallen into disrepair. Since 1997, BULOG, the agency charged with stabilizing rice prices, has been unable to stabilize domestic rice prices. During 1998, the agency was forced to abandon its effort to prevent rice price increases and the domestic price of rice doubled in four months. In December 1998, the government set an unrealistically high floor price for paddy, and BULOG has not been able to defend that floor price. The agency instead buys about enough rice for its own distribution needs and fails to defend either floor or ceiling prices for rice. Due to ineffective price stabilization, the government removed BULOG’s international trade monopoly on rice imports in 1999.

Public investment policy for rice has continued as before, but at lower and less effective levels. Some of the earlier irrigation and transport infrastructure now requires rehabilitation and greater maintenance. Budgetary stringency during the macro crisis has added greatly to the difficulties of expanding rural infrastructure.

Macroeconomic policies became much less stable because of the macro crisis. With the important exception of 1998 (when the annual rate of inflation exceeded 80 percent), the government’s monetary and fiscal policies have kept inflation in reasonable check (8-12 percent per year). But enormous uncertainty for the Indonesian economy has come from the widely fluctuating foreign exchange rate, which depreciated from about Rupiah 2,500 per US dollar in mid-1997 to over 16,000 in early 1998 before settling in a range of 8,000-12,000 thereafter.

Rural regulations have been reformed. Rice farmers in East and Central Java are no longer required to plant sugarcane for mills operated by the Ministry of Agriculture. However, some Javanese farmers complain that local government officials still attempt to regulate their choices of cropping patterns.

Rice Policy in the Framework for Agricultural Policy Analysis

In principle, governments form agricultural strategies by choosing a set of policies to further their objectives subject to the constraints on the agricultural economy. This conceptual framework has been illustrated by contrasting rice policy in Indonesia in two periods – the Green Revolution of the 1970s and 1980s and the macro crisis period of 1997-present. The earlier period is analyzed in the RPI book, whereas the recent period is examined in numerous papers written by the FPSA team, all available in the “Food Policy Agenda” section of the project website (www.macrofoodpolicy.com).

During the Green Revolution, rice strategy was to introduce a new technology of high-yielding varieties, improved water control, chemical fertilizer applications, and better marketing and irrigation infrastructure. Fertilizer subsidies, stable rice prices, free irrigation water, better roads, and stable macro-economic conditions complemented this new technology and encouraged its rapid dissemination. These policies significantly altered the economic constraints and allowed a tripling of output and incomes from rice.
These happy circumstances promoted all three primary objectives – efficiency, equity, and security. The increases in rice production were created by improved technologies, not policy transfers, rice prices were maintained at about the trend of world prices, and efficiency was improved. Technological gains permitted increases in rice farmer profits and incomes while consumers of rice benefited from the gradually declining world and domestic rice prices. Hence, there were few trade-offs in equity. Food security improved as Indonesia eliminated rice imports with efficient increases in domestic output, in an environment of relatively stable domestic rice prices. The strategy to promote the dissemination of new high-yielding technologies was thus successful on nearly all accounts.

During the recent macro-economic crisis, rice strategy has fallen into disarray. The rice strategy has been to attempt to aid rice farmer incomes in a period of unusually low world rice prices. In contrast to the earlier period, there has not been any new technology to disseminate. Nearly all Indonesian farmers now plant high-yielding varieties of rice. Severe budgetary pressure and the consequent need to limit government capital spending have hampered the government’s ability to make further improvements in irrigation and transportation. Struck by fiscal limitations, contradictory policies, and charges of corruption and mismanagement, BULOG has not been able to stabilize rice prices. Rapid and sizeable swings in the exchange rate have greatly increased the uncertainties in rice production and marketing.

Difficult trade-offs now affect rice policy. The principal policy instruments have been the specific tariff on rice imports, which has helped to raise domestic prices by 25-30 percent, and a limited subsidy on rice consumption in selected poor villages and urban centers. The rural and urban poor have been compensated only partly for the increase in rice prices caused by policy. Public opinion favoring rice farmers argues for maintaining or even raising the rice tariff, especially to offset unusually low world rice prices. The opposite opinion, favoring poor rice consumers, argues that the country should take advantage of low world rice prices to benefit the nutrition of poor Indonesians and to alleviate their poverty. The weights that policy makers place on these conflicting objectives thus take center stage in the policy debate as Indonesia seeks to identify a consistent and successful rice strategy.
Chapter 2: Introduction to the Policy Analysis Matrix

In their efforts to raise agricultural productivity, the central, provincial, and local governments in Indonesia can intervene in agriculture by using three different kinds of policies – agricultural price policies, public investment policies, and macro-economic policies. Macro-economic policies can only be imposed at the central level and require separate analysis by specialists in macroeconomics. Agricultural economists study the impacts of price and investment policies. Fortunately, the efficacy of both agricultural price policies and public investments in agriculture can be studied with one approach – the Policy Analysis Matrix (PAM). PAM results show the individual and collective effects of price and factor policies. The PAM also provides essential baseline information for benefit-cost analysis of agricultural investment projects. The main purpose of this chapter is to show how and why the PAM method can apply to both price and project analysis.

Issues and Purposes of PAM Analysis

The PAM methodology provides information to help central and regional policy makers address three central issues of agricultural policy analysis. One issue is whether agricultural systems are competitive under existing technologies and prices – that is, whether farmers, traders, and processors earn profits facing actual market prices. Prospective price policies would change the value of output or the costs of inputs and thus the private profitability of the system. A comparison of private profitability before and after the policy change measures the impact of the policy change on competitiveness in market prices.

A second issue is the impact of new public investment in infrastructure on the efficiency of agricultural systems. Efficiency is measured by social profitability, the valuation of profits in efficiency prices. Successful public investment (in irrigation or transportation) would raise the value of output or lower the costs of inputs. A comparison of social profits before and after the new public investment measures the increase in social profits.

A third issue, closely related to the second, is the impact of new public investment in agricultural research or technology on the efficiency of agricultural systems. Successful public investment in new seeds, farming techniques, or processing technologies would enhance farming or processing yields and thus would increase revenues or decrease costs. A comparison of social profits before and after the investment in research measures the gain in social profitability.

The three principal purposes of the Policy Analysis Matrix (PAM) methodology are to provide information and analysis to assist policy makers in these three central areas of agricultural policy. The construction of a PAM for an agricultural system allows one to calculate private profitability – a measure of the competitiveness of the system at actual market prices. Similar analyses of other systems permit a ranking of the competitiveness of agricultural systems at market prices. The calculation of private profitability or competitiveness is carried out in the first (top) row of the PAM matrix. This result serves as the baseline for benefit-cost analysis in actual market (private) prices, as explained in Chapter 3.

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9 PAM, Chapter 2, pp. 17-18
10 PAM, pp. 30-31
A second purpose of the PAM approach is to estimate the agricultural system’s social profitability – the result if products produced and inputs used are valued in efficiency prices (social opportunity costs). Complementary analyses of other systems allow a ranking of the efficiency of agricultural systems. The calculation of social profitability is carried out in the second (middle) row of the PAM matrix. This outcome provides baseline information for social benefit-cost analysis, using efficiency prices, as shown in Chapter 4.

The third purpose of PAM analysis is to measure the transfer effects of policies. By contrasting revenues and costs before and after the imposition of a policy, one can determine the impact of that policy. The PAM method captures the effects of policies influencing both products and factors of production (land, labor, and capital). The measurement of the transfer effects of policies is carried out in the third (bottom) row of the PAM matrix, as demonstrated in detail in Chapter 5.

**Identities of the Policy Analysis Matrix**

A matrix is an array of numbers (or symbols) that follows two rules of accounting – one defining relationships across the columns of the matrix and the other defining relationships down the rows of the matrix. These accounting relationships are termed the identities of the matrix because they are true by definition. An analyst can specify any identities in a matrix so long as the definitions are applied consistently. The PAM matrix consists of two accounting identities – the profitability identity and the divergences identity.

The profitability identity in PAM is the accounting relationship across the columns of the matrix. Profits are defined as revenues less costs. All entries in the PAM matrix under the column defined “profits” thus are identically equal to the difference between the columns containing “revenues” and those containing “costs” (including both costs of tradable inputs and costs of domestic factors).

The divergences identity in PAM is the relationship down the rows of the matrix. Divergences cause private prices to differ from their social counterparts. A divergence arises either because a distorting policy intervenes to cause a private market price to diverge from an efficient price or because underlying market forces have failed to provide an efficient price. All entries in the PAM matrix under the third row, defined as “effects of divergences,” thus are identically equal to the difference between entries in the first row, measured in “private prices,” and those in the second row, measured in “social prices.”

**Profitability Identity – Private Profits**

Figure 2.1 shows only the entries for the first row of a PAM, which contains measures of prices in private prices (the observed market prices). The symbol A measures revenues in private prices, the symbol B stands for tradable input costs in private prices, the symbol C represents domestic factor costs in private prices, and the symbol D is private profit.

---

<sup>11</sup> *PAM*, pp. 18-19
In empirical PAM analysis, the revenue and cost categories in private prices (entries A, B, and C) are based on data from farm and processing budgets. The symbol D, profits in private prices, is found by applying the profitability identity. According to that accounting principle, D is identically equal to A - (B + C). Private profits in PAM thus are a residual discovered by subtracting private costs from private revenues.\textsuperscript{12}

The calculation of private profits, from data in farm and processing budgets, measures the competitiveness of agricultural systems. One key result for agricultural policy thus is obtained from the first row of the PAM matrix. Procedures for the empirical estimation of private profitability are outlined in Chapter 3.

To compare results from agricultural systems that produce unlike outputs, analysts compute ratios.\textsuperscript{13} In the calculation of ratios, the unit of measurement (sometimes called the numeraire), such as Rupiah per kilogram of rice, cancels out. The computation of ratios thus avoids having to compare profits per kilogram of rice, for example, with profits per kilogram of soybeans. The comparison of competitiveness of unlike systems is facilitated by computing the private benefit-cost ratio (PBCR) for each system and then comparing these ratios across all the systems. The PBCR is equal to the ratio of private revenues to private costs, or PBCR = A/(B + C).

**Profitability Identity – Social Profits**

Figure 2.2 depicts only the entries for the second row of a PAM, which contains measures of prices in social prices (prices that would result in the best allocation of resources and thus the highest generation of income).

\[ PAM, \text{ pp. 19-20} \]

\[ PAM, \text{ pp. 25-26} \]
The symbol \( E \) measures revenues in social prices, the symbol \( F \) stands for tradable input costs in social prices, the symbol \( G \) represents domestic factor costs in social prices, and the symbol \( H \) is social profit. Countries achieve rapid economic growth by promoting activities that generate high social profits (large positive \( H \)).

In an empirical PAM analysis, the revenue and cost categories in social prices (entries \( E \), \( F \), and \( G \)) are based on estimates of the social opportunity costs of commodities produced and inputs used in production. These estimated social (or efficiency) prices then are applied to the original quantities of outputs and inputs (those used in the calculation of private profits in the top row of PAM). The symbol \( H \), profits in social prices, is found by applying the profitability identity. According to that accounting principle, \( H \) is identically equal to \( E - (F + G) \). Social profits in PAM thus are a residual discovered by subtracting social costs from social revenues.\(^{14}\)

The calculation of social profits, from estimates of social prices applied to input-output data in farm and processing budgets, measures the efficiency of agricultural systems. A second key result for agricultural policy thus is obtained from the second row of the PAM matrix. Procedures for the empirical estimation of social profitability are summarized below and detailed in Chapter 4.

The social (efficiency) prices for tradable outputs and inputs are the comparable world prices – import prices for commodities that are partly imported (importable) or export prices for commodities that are partly exported (exportable). The efficiency value (social opportunity cost) of producing an additional ton of an importable commodity (e.g., rice in Indonesia) is the amount of foreign exchange saved by replacing a ton of imports – given by the import price. Similarly, the social opportunity cost of producing an additional ton of an exportable commodity (e.g., palm oil in Indonesia) is the amount of foreign exchange earned by increasing exports by a ton – given by the export price.

The social (efficiency) prices for domestic factors of production (land, labor, and capital) are estimated also by application of the social opportunity cost principle. Because domestic factors are not tradable internationally and thus do not have world prices, their social opportunity costs are estimated through observations of rural factor markets. The intent is to find how much output and income are foregone because the factor is used to produce the commodity under analysis (e.g., rice) rather than the next best alternative commodity (e.g., sugarcane).

To compare social results from agricultural systems that produce unlike outputs, analysts again compute ratios. Comparison of the efficiency of unlike systems is done by computing the social benefit-cost ratio (SBCR) for each system and then comparing these ratios across all the systems. The SBCR is equal to the ratio of social revenues to social costs, or \( \text{SBCR} = E/(F + G) \).

### Divergences Identity

Figure 2.3 shows all twelve entries for a PAM, given by the letter symbols A through L. It adds a third row termed the Effects of Divergences row. As noted above, divergences arise

\(^{14}\) *PAM*, pp. 20-22
from either distorting policies or market failures. Either source of divergence causes observed market prices to differ from their counterpart efficiency prices. The symbol I measures divergences in revenues (caused by distortions in output prices), the symbol J stands for divergences in tradable input costs (caused by distortions in tradable input prices), the symbol K represents divergences in domestic factor costs (caused by distortions in domestic factor prices), and the symbol L is the net transfer effect (arising from the total impact of all divergences).

*Figure 2.3. Divergences in the Policy Analysis Matrix*

<table>
<thead>
<tr>
<th></th>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Factor</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Social</td>
<td>E</td>
<td>F</td>
<td>G</td>
</tr>
<tr>
<td>Effects of Divergences</td>
<td>I</td>
<td>J</td>
<td>K</td>
</tr>
</tbody>
</table>

In empirical PAM analysis, the effects of divergences (in the third, bottom row) are found by applying the divergences identity. According to that accounting principle, all entries in the PAM matrix under the third row (defined as Effects of Divergences) are identically equal to the difference between entries in the first row (measured in private prices) and entries in the second row (measured in social prices). Therefore, I is identically equal to (A – E), J is identically equal to (B – F), K is identically equal to (C – G), and L is identically equal to (D – H). The sources of divergences are introduced below, and procedures for the empirical estimation of divergences are detailed in Chapter 5.

One source of divergence is the existence of a market failure. A market fails if it does not generate competitive prices that reflect social opportunity costs and lead to an efficient allocation of products or factors. Three basic types of market failures create divergences. The first is monopoly (seller control over market prices) or monopsony (buyer control over market prices). The second are negative externalities (costs for which the imposer cannot be charged) or positive externalities (benefits for which the provider cannot receive compensation). The third are factor market imperfections (inadequate development of institutions to provide competitive services and full information).

Efficient policy is a government intervention to correct a market failure and thus offset a divergence. For example, successful regulation of a monopoly would reduce seller prices, cause private and social prices to become equal, and increase income.

The second source of divergence is distorting government policy. Distorting policy, implemented to further non-efficiency objectives (equity or security), prevents an efficient allocation of resources and thus creates divergences. A tariff on rice imports, for example, could be imposed to raise farmer incomes (equity objective) and increase domestic rice production (security objective), but it would create efficiency losses if the replaced rice imports were cheaper than the costs of domestic resources used to produce the additional rice. Hence, a trade-
off would arise, and policy makers would need to assign weights to these conflicting objectives to decide whether to introduce the tariff.

The most efficient outcome could be achieved, in principle, if the government were able to enact efficient policies that offset market failures and if the government were to decide to override non-efficiency objectives and remove distorting policies. If these actions – the introduction of efficient policies and the removal of distorting policies – could be carried out, divergences would be offset and the effects of divergences (measured in the bottom row of PAM) would be zero. In this idealized example, all entries in the bottom row of the PAM matrix – I, J, K, and L – would be zero. Hence, the entries in the top row would be identical to those in the second row, i.e., private revenues, costs, and profits would be the same as social revenues, costs, and profits (A = E, B = F, C = G, and D = H).

**Research Inputs and Outputs in the Policy Analysis Matrix**

The principles and practices of the PAM are illuminated through examination of the research inputs and research outputs in the matrix. Because the PAM is based on two accounting identities, the analyst needs only to enter data into half of the entries of the matrix (called the research inputs). The remaining entries then become results of the analysis (called the research outputs). Of the twelve entries in the PAM matrix, therefore, only six need to be data or research inputs. The remaining six entries then can be found as research results by applying the profitability or divergences identities.

**Research Inputs for Efficiency and Policy Analysis**

The six categories of research inputs in empirical PAM analysis (A, B, C, E, F, and K) are underlined in the PAM matrix shown in Figure 2.4.

![Figure 2.4. Research Inputs in the Policy Analysis Matrix](image)

Most of the data for the six research inputs are obtained from the activity budgets (farming, marketing, and processing) for each agricultural system. The data for private revenues (A) and costs (B, C) typically come directly from these budgets. These budgets usually are based on both secondary data (gathered by other researchers) and primary data (obtained by the field research team), as described in Chapter 3.

The entries for social revenues (E) and social tradable input costs (F) come partly from the system budgets and partly from government documents or industry sources, as detailed in Chapter 4. The information on input-output relationships (quantities of inputs needed per hectare or per ton of output) typically is assumed to be the same in both private and social analysis and thus is obtained from the system budgets (and then from the first row of PAM). However, social prices differ from their private counterparts if distorting policy or market failures cause
The social prices for tradable outputs and inputs are comparable import or export prices, found in government or industry documentation.

The entries for social valuation of domestic factor costs (G) cannot be observed directly in the field or taken from government or industry documents (because comparable world prices do not exist for factors). Instead, field researchers study rural factor markets to search for the presence or absence of divergences in each factor market – effective distorting policies or significant market failures. Hence, the entry for factor divergences (K) becomes a research input, which then is used to estimate social factor prices from observed private factor prices. This empirical procedure for factor markets is described in Chapter 4.

The six categories of research results in empirical PAM analysis (D, G, H, I, J, and L) are underlined in the PAM matrix shown in Figure 2.5.

![Figure 2.5. Research Results in the Policy Analysis Matrix](image)

Research results in the PAM approach flow directly from application of either the profitability identity or the divergences identity. Since these accounting principles govern the relationships in the PAM matrix, the key results are obtained from straightforward subtraction among entries of research inputs.

The first two results – private profits (D) and social profits (H) – are obtained from application of the profitability identity (revenues less costs equal profits). Private profits (D), a measure of competitiveness, equal private revenues (A) less private costs (tradable input costs (B) and domestic factor costs (C)). Similarly, social profits (H), a measure of efficiency, equal social revenues (E) less social costs (tradable input costs (F) and domestic factor costs (G)). The calculation of social profits (H), however, must await the estimation of social factor prices (G), itself a research result.

The next two results – output transfers (I) and tradable input transfers (J) – are obtained from application of the divergences identity (entries in private prices less entries in social prices equal the effects of divergences). Output transfers (I), a measure of the implicit tax or subsidy on outputs, equal private revenues (A) less social revenues (E). In turn, tradable input transfers (J), a measure of the implicit tax or subsidy on tradable inputs, equal private tradable input costs (B) less social tradable input costs (F).

The last two results – social factor prices (G) and net transfers (L) – are less straightforward. As noted above, social factor prices (G) are found by adjusting private factor prices (C) for observed divergences causing factor price transfers (K). Because the divergences identity requires that (C – G) = K, it is also true that (C – K) = G. The final result, net transfers
(L), can be found by applying either the profitability identity \((I - (J + K) = L)\) or the divergences identity \((D - H = L)\). The net transfer \((L)\) thus can be interpreted either as the net effect of all divergences or as the difference between private and social profitability. This single measure thus shows the extent to which distorting policies and market failures implicitly subsidize an agricultural system (by transferring resources into the system) or tax that system (by transferring resources away from the system).
Chapter 3: Private Benefit-Cost Analysis (The PAM's Top Row)

The empirical application of the Policy Analysis Matrix (PAM) begins with an assessment of revenues, costs, and profits in private (actual market) prices. Data on private revenues and costs are entered in the top row of the PAM, often termed the “private row.” Figure 3.1 shows the entries for the top row of PAM, which contains measures in private prices (the observed market prices). As noted in Chapter 2, the symbol A measures revenues in private prices, the symbol B stands for tradable input costs in private prices, the symbol C represents domestic factor costs in private prices, and the symbol D is private profit. Application of the profitability identity \( D = A - (B + C) \), introduced in Chapter 2, to private revenues and costs gives private profits.

![Figure 3.1. Private Profits in the Policy Analysis Matrix](image)

<table>
<thead>
<tr>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Factor</td>
</tr>
<tr>
<td>Private</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The purpose of this chapter is to explain how an analyst goes about the practical task of deciding what data to use in the top row of PAM and how to find that information.

Constructing PAMs for Commodity Systems

Most agricultural policymakers are interested mainly in understanding competitiveness and efficiency at the farm-gate, since they are concerned with farmer welfare. But comparable world prices are needed to assess efficiency (as explained in Chapter 4). For many agricultural commodities, there are no comparable world prices until after the raw commodity has been processed (e.g., from paddy to milled rice). Comparable world prices for processed goods are available only at the nearby wholesale markets. Hence, PAM analysts need to define their studies of commodity systems to include four activities – farm production, farm-to-processor transportation, processing, and processor-to-wholesale-market transportation. Figure 3.2 gives a visual representation of these four activities in a single commodity system and summarizes the content of each activity.

The numeraire (unit of account) typically differs across the four activities within a commodity system. In most instances, the analyst chooses the numeraire for the processed product in the nearby wholesale market (e.g., Rupiahs per kilogram of milled rice). Occasionally, it is appropriate to use instead a numeraire that measures revenue per hectare (e.g., Rupiahs per hectare), the farm-gate unit of account. In either case, it is necessary to use conversion ratios as one moves from the budget for one activity to another within a commodity system. These conversion ratios (Figure 3.3), contain important physical information such as yields (tons of paddy per hectare) and milling conversion ratios (tons of rice per ton of paddy).
Figure 3.2. The Structure of a Commodity System for PAM Analysis

ACTIVITIES

FARM PRODUCTION

Inputs and outputs for production of raw materials. Evaluation stops at farm gate.

FARM-TO-PROCESSOR

Commodity moves from farm gate to processing site (may include storage and handling as well as transportation costs.)

PROCESSING

Commodity processed into consumer acceptable form (may involve physical transformation or just packing, handling, and quality control.

PROCESSOR –TO – WHOLESALE MARKET

Commodity moved from processing site to market where domestic activity is comparable to tradable product (may include inputs and outputs for farm-to-wholesale market if processing activity is irrelevant).

Source: Adapted from PAM, p. 133

Figure 3.3. Conversion Ratios Used in the Calculation of System Cost and Returns

<table>
<thead>
<tr>
<th>Activity</th>
<th>Original units of measure for the activity</th>
<th>Conversion ratios for activity and secondary product revenues</th>
<th>Adjusted units of measure for activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm</td>
<td>rupiahs/hectare</td>
<td>(hectares/mt paddy) X (mt paddy/mt milled rice)</td>
<td>rupiahs/mt milled rice</td>
</tr>
<tr>
<td>Farm-to-processor</td>
<td>rupiahs/mt paddy</td>
<td>mt paddy/mt milled rice</td>
<td>rupiahs/mt milled rice</td>
</tr>
<tr>
<td>Processing</td>
<td>rupiahs/mt milled rice</td>
<td>None</td>
<td>rupiahs/mt milled rice</td>
</tr>
<tr>
<td>Processor-to-market</td>
<td>rupiahs/mt milled rice</td>
<td>None</td>
<td>rupiahs/mt milled rice</td>
</tr>
<tr>
<td>Farm</td>
<td>rupiahs/hectare</td>
<td>None</td>
<td>rupiahs/hectare</td>
</tr>
<tr>
<td>Farm-to-processor</td>
<td>rupiahs/mt paddy</td>
<td>mt paddy/hectare</td>
<td>rupiahs/hectare</td>
</tr>
<tr>
<td>Processing</td>
<td>rupiahs/mt milled rice</td>
<td>(mt milled rice/mt paddy) X (mt paddy/hectare)</td>
<td>rupiahs/hectare</td>
</tr>
<tr>
<td>Processor-to-market</td>
<td>rupiahs/mt milled rice</td>
<td>(mt milled rice/mt paddy) X (mt paddy/hectare)</td>
<td>rupiahs/hectare</td>
</tr>
</tbody>
</table>

Source: PAM, p. 135
The Construction of Private Budgets for PAM

What kinds of data should be entered in the top (Private) row of a PAM? Empirical application of the PAM approach is based on the compilation of data in budgets. Because the PAM approach is based on budgets, PAM input data are revenues and costs and profits are found by subtraction as a research result. Four different budgets are put together for each agricultural system – one on farming, a second on marketing (from the farm to the processing center), a third on processing, and a fourth on marketing (from the processing center to the wholesale market). But before beginning the search for budget information, the PAM analyst needs to select the representative commodity systems that will be studied. That choice depends on the policy questions that will be addressed by the results of the study.

Selecting Representative Commodity Systems

PAM analysis is carried out at the individual commodity level (for rice, soybeans, coconuts, or cloves). An early issue that PAM researchers confront is how many agricultural commodity systems to study. This decision depends critically on the nature of the questions to be addressed in the study. If the policy of interest were a tariff on rice, for example, the analysts would want to choose a wide range of rice-production systems, including some marginal ones that might require tariff protection to maintain private profitability. Or if the question were a subsidy on chemical fertilizers, the researchers would want to select a range of crops that use fertilizer, including some systems that might have negative profits without the subsidy.

In general, researchers need to stratify the population of farmers according to a subset of several variables – the commodities of interest, the geographic regions or agro-climatic zones (distinguished by rainfall, soils, elevation, and slope), the seasons of production and cropping rotations (one wet season and one or two dry seasons), the agricultural technologies (differentiated by water control, inter-cropping, high-yielding seeds, modern inputs, and mechanization), and the areas cropped (owned, rented-in, and rented-out). By choosing a subset of these stratification variables, researchers can select a workable number of agricultural systems for which to create PAMs. These variables need to be chosen carefully, because the choice of only four variables, for example, leads to sixteen commodity systems. That number is near the maximum that any study can easily cover, and it is usually preferable to narrow the system coverage to half that number or even less.

Constructing Farm Budgets

A number of guidelines assist the compilation of farm budgets. For most PAM analyses, the farm budgets should be based on actual data from a recent time period, not on optimal performance. The budgets are intended to be representative of current average farming

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16 Detailed information on how to construct budgets at the farm and post-farm levels is presented in *PAM*, Chapters 9 and 10, pp. 151-187.

17 Details on the assembly of data in budget formats are set forth in the accompanying computer tutorial designed to teach PAM application on microcomputers.

18 The selection of commodity systems is discussed in *PAM*, Chapter 8, pp. 131-150.

19 The construction of farm budgets is discussed in *PAM*, Chapter 9, pp. 151-170.
behavior, not that of the best and most progressive farmers. The data in the budgets should be measures of average costs and returns. In this important respect, PAM analysis differs from efforts to build supply schedules of agricultural commodities, which are based on marginal (incremental) costs of production. The numeraire (the units used to denominate entries in the PAM) is usually domestic currency units per quantity (ton or kilogram) of output, since only farming budgets (and not marketing and processing budgets) can be done using domestic currency units per hectare. The categories and quantity and price measures for inputs and outputs in farm activity budgets are summarized in Figure 3.4.

**Figure 3.4. Inputs and Outputs in Farm Activity Budgets**

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity measure per numeraire</th>
<th>Price measures</th>
</tr>
</thead>
</table>
| Fixed inputs: buildings, fences, land development
Investments, irrigation infrastructure and equipment, machinery, machinery accessories, tools, work animals | Useful life
Share of annual use | Purchase price
Salvage value, rate of return |
| Direct labor: unskilled male, female, child; skilled labor, by task | Days or hours | Wage per day or wage per hour |
| Intermediate inputs: seeds, fertilizers, insecticides, custom machinery services, repair and servicing equipment | Weight or volume; most services charges are not quantifiable | Farm-gate price per unit |
| Outputs: main products | Weight or volume | Farm-gate price per unit |

Source: PAM, p. 157

Empirical PAM analysis usually begins with the compilation of synthetic budgets based on secondary data collected by other researchers. These early budgets are synthetic in two senses – they are not the result of original fieldwork and thus are somewhat artificial, and they are syntheses of existing work. The purpose of compiling synthetic budgets is to guide the researcher toward essential missing or conflicting information. Actual fieldwork ideally then can focus on completion, verification, and updating of the synthetic budgets rather than starting from the beginning and building all new budgets. The computation of synthetic budgets also encourages researchers to carry out a systematic review of existing work on their commodities and regions of interest and thus grounds their research reports firmly in the existing literature.

In carrying out PAM analyses, most of the time spent by researchers is devoted to interviewing farmers, traders, transporters, and processors in the field. Careful fieldwork is crucial to understanding the farming systems, but it is also expensive in consuming scarce manpower and other project resources. The budget data needed for PAM entries can be based on relatively small samples of farmers, traders, and processors. PAM entries are modal values (central tendencies), not econometrically-estimated parameters drawn from statistically valid samples. Field observations and the allocation of researchers’ time in fieldwork take advantage of this property. Researchers are encouraged to seek a wide range of informed and expert
opinion about the agricultural systems rather than to meet imposed standards of large sample size.

The key to successful fieldwork is to make every effort to ensure that respondents understand the questions asked. To verify their responses it is important to check key answers (yields, fertilizer applications, output prices, wage rates, and land rental rates) with local experts – traders, brokers, the village head, agricultural officials, and local representatives of the Central Bureau of Statistics. But errors inevitably creep into all field investigations.

PAM researchers carrying out fieldwork thus need to be aware of ways to cross check the reliability of the data they are collecting. If private profits are negative, the farmer must be able to explain this result (usually because of unexpected poor weather or interrupted marketing of inputs or outputs).

Researchers also need to check for possible inconsistencies in data from various respondents. Variations in yields (output per hectare) need to be consistent with applications of fertilizers and labor. In processing, conversion factors (e.g., quantity of milled rice per quantity of paddy) and qualities of outputs (e.g., percentage of broken kernels in milled rice) need to be analyzed consistently across processing units. In cleaning their raw data, PAM researchers should search for inexplicable outliers and then formulate and apply consistent rules for accepting or rejecting interview data. Particularly with small sample sizes, however, researchers should be cautious before rejecting the results of an apparently inconsistent and inaccurate interview.

In making estimates of private and social prices in farm budgets, the principle of opportunity costs needs to be applied consistently and widely. Private opportunity costs reflect market choices. The opportunity cost of hired labor, for example, is given by the market wage rate, adjusted for any meals and transportation provided by the farmer, trader, or processor. In contrast, the opportunity cost of family labor is approximated by the market wage rate (if the worker otherwise could find a job off the farm at that rate). The rental value of a certain quality and location of land depends closely on the productivity of that land in producing various crops – as reflected in the land rental rate or in the land-rent equivalent of share-cropping arrangements.

Social opportunity costs, in contrast, reflect foregone national income (as explained and illustrated in Chapter 4). The social rental rate for land devoted to producing rice, for example, is given by the social profitability of that land in its best alternative use. The opportunity cost principle – that the value of resources is best reflected by the worth of those resources in alternative uses – is the main underlying conceptual principle in budget-based analyses, such as the PAM approach.

**Constructing Post-farm Budgets**

The principles and procedures for putting together post-farm (processing and transportation) budgets are similar to those used for farm budgets. In both instances, researchers select representative activities (farm and post-farm) based on the policy issues under

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20 The construction of post-farm budgets is discussed in *PAM*, Chapter 10, pp. 171-187.
Budgets for both on-farm and post-farm activities require careful compilation of data on revenues and costs and strict application of the opportunity cost principle. Although the post-farm budgets require different numeraires than those used for on-farm budgets (as explained earlier in this chapter), all of the other procedures outlined for farm budgets apply for post-farm budgets. Both are based on average, rather than marginal, cost data. Analysts in both cases should begin by compiling synthetic budgets from secondary information and then verify results through field surveys. In both types of budgets, researchers can rely on small sample sizes to construct the budgets. All PAM activity budgets need to be crosschecked for data accuracy and quality.

Post-farm budgets differ from their on-farm counterparts in two main ways. Because typically there are far fewer processors and transporters than there are farmers, primary surveys are easier to carry out for the post-farm activities and coverage in the post-farm sample is wider. Further, most farmers in Indonesia use little, if any, fixed capital equipment. In contrast, processing and transportation usually involve high fixed capital costs. Hence, economies of size – declining costs per unit handled as quantities processed or transported increase – are much more important in the post-farm activities than in farming. Measuring the effects of size economies and estimating depreciation and returns to capital thus are critical issues in post-farm budgets but of little importance in farm budgets.

Once the PAM researcher has compiled the secondary (based on others’ studies) and primary (field-based) information on private revenues and costs for farm and post-farm budgets, s/he is in position to complete the top row of the PAM. The PAM for a commodity system is the summation of the PAMs for the four component activities (farm, farm-to-processor, processing, and processor-to wholesale-market). Application of the profitability identity \( D = A - (B+C) \) gives private profits, an indicator of competitiveness in private (actual market) prices. This calculation is identical to that done for private benefit-cost analysis. The usual indicator is the private benefit-cost ratio \( PBCR = A/(B+C) \), which gives a numeraire-free ranking of private profitability.

**Tutorial Example of Private Profitability**

The computer tutorial contains a full explanation of how to calculate private costs, returns, and profits in PAM analysis. The illustrative example used is a high-yielding paddy system in Indonesia. The analysis proceeds in three steps that are summarized here. The reader is encouraged to carry out the computer exercise after completing this chapter, because the tutorials are designed to complement the discussion here.

The first step is to construct a table of physical input-output relationships for the paddy system. This numerical description of the production function summarizes the technology used in this system. The entries in Table 3.1 are measures of quantities per hectare planted to paddy. In this illustrative system, among the many inputs used the representative farmer applies 240 kilograms of urea fertilizer and 600 labor hours for crop care per hectare of paddy land. The average yield of paddy is 6,000 kilograms per hectare. These input-output coefficients are drawn from the synthetic budgets, the farm interviews, and local expert information.
### Table 3.1. Physical Input-Output

<table>
<thead>
<tr>
<th>I-O</th>
<th>Quantities</th>
<th>HY Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradables</td>
<td>Fertilizer (kg/ha)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urea</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>SP-36</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>KCl</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>ZA</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Chemicals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liquid pesticide (liters/ha)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Granulated pesticide (kgs/ha)</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Seed (kg/ha)</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Fuel (liters/ha)</td>
<td>65</td>
</tr>
<tr>
<td>Factors</td>
<td>Labor (hr/ha)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seedbed Prep</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Crop Care</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>Harvesting</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Threshing</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Drying</td>
<td>-</td>
</tr>
<tr>
<td>Capital</td>
<td>Working Capital (Rp/ha)</td>
<td>2,000,000</td>
</tr>
<tr>
<td></td>
<td>Tractor Services (hr/ha)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Thresher (hr/ha)</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Land (ha)</td>
<td>1</td>
</tr>
<tr>
<td>Output</td>
<td>(kg/ha)</td>
<td>6,000</td>
</tr>
</tbody>
</table>

The second step is to compile a table of private (actual market) prices for each of the inputs used and outputs produced in the system. These prices should be representative of the base year of the study. The private prices for the high-yielding paddy system are presented in Table 3.2. For example, the cost of urea fertilizer is Rp 1,100 per kilogram, the wage rate for labor used in crop care is Rp 1,600 per hour, and the farm-gate price of the paddy produced is Rp 1,250 per kilogram.

### Table 3.2. Private Prices

<table>
<thead>
<tr>
<th>P-Prices</th>
<th>Quantities</th>
<th>HY Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradable</td>
<td>Fertilizer (Rp/kg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urea</td>
<td>1,100</td>
</tr>
<tr>
<td></td>
<td>SP-36</td>
<td>1,400</td>
</tr>
<tr>
<td></td>
<td>KCl</td>
<td>1,600</td>
</tr>
<tr>
<td></td>
<td>ZA</td>
<td>1,000</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Liquid insecticide (liters/ha)</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td>Granulated insecticide (kg/ha)</td>
<td>8,000</td>
</tr>
<tr>
<td></td>
<td>Seed (Rp/kg)</td>
<td>2,500</td>
</tr>
<tr>
<td></td>
<td>Fuel (Rp/liter)</td>
<td>1,500</td>
</tr>
<tr>
<td>Factors</td>
<td>Labor (Rp/hr)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.2. Private Prices

<table>
<thead>
<tr>
<th>P-Prices</th>
<th>Quantities</th>
<th>HY Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradables</td>
<td>Fertilizer (Rp/kg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seedbed Prep</td>
<td>1,600</td>
</tr>
<tr>
<td></td>
<td>Crop Care</td>
<td>1,600</td>
</tr>
<tr>
<td></td>
<td>Harvesting</td>
<td>1,600</td>
</tr>
<tr>
<td></td>
<td>Threshing</td>
<td>1,600</td>
</tr>
<tr>
<td>Capital</td>
<td>Working Capital (%)</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Tractor Services (Rp/hr)</td>
<td>12,500</td>
</tr>
<tr>
<td></td>
<td>Thresher (Rp/hr)</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td>Land (Rp/ha)</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Output</td>
<td>(Rp/kg)</td>
<td>1,205</td>
</tr>
</tbody>
</table>

The third and final step is to create a budget in private (actual market) prices by multiplying the quantity entries in the input-output table times the price entries in the private prices table. Table 3.3 shows the result of this calculation for the high-yielding paddy system. For this rice system, private profit (after paying land rent) is 37 percent of private revenues and the private benefit-cost ratio (PBCR) is Rp 7,230,000/ Rp 4,548,500 or 1.59.

Table 3.3. Private Prices Budget

<table>
<thead>
<tr>
<th>P-Budget</th>
<th>Quantities</th>
<th>HY Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradables</td>
<td>Fertilizer (Rp/ha)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urea</td>
<td>264,000</td>
</tr>
<tr>
<td></td>
<td>SP-36</td>
<td>140,000</td>
</tr>
<tr>
<td></td>
<td>KCl</td>
<td>32,000</td>
</tr>
<tr>
<td></td>
<td>ZA</td>
<td>150,000</td>
</tr>
<tr>
<td></td>
<td>Chemicals</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Liquid insecticide (Rp/ha)</td>
<td>75,000</td>
</tr>
<tr>
<td></td>
<td>Granulated insecticide (Rp/ha)</td>
<td>120,000</td>
</tr>
<tr>
<td></td>
<td>Seed (Rp/ha)</td>
<td>87,500</td>
</tr>
<tr>
<td></td>
<td>Fuel (Rp/ha)</td>
<td>97,500</td>
</tr>
<tr>
<td>Factors</td>
<td>Labor (Rp/ha)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Seedbed Prep</td>
<td>160,000</td>
</tr>
<tr>
<td></td>
<td>Crop Care</td>
<td>960,000</td>
</tr>
<tr>
<td></td>
<td>Harvesting</td>
<td>320,000</td>
</tr>
<tr>
<td></td>
<td>Threshing</td>
<td>240,000</td>
</tr>
<tr>
<td>Capital</td>
<td>Working Capital (Rp/ha)</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>Tractor Services (Rp/ha)</td>
<td>250,000</td>
</tr>
<tr>
<td></td>
<td>Thresher (Rp/ha)</td>
<td>52,500</td>
</tr>
<tr>
<td></td>
<td>Land (Rp/ha)</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Output</td>
<td>Total Revenue (Rp/ha)</td>
<td>7,230,000</td>
</tr>
<tr>
<td></td>
<td>Total Cost (excluding land) (Rp/ha)</td>
<td>3,048,500</td>
</tr>
<tr>
<td></td>
<td>Profit (excluding land) (Rp/ha)</td>
<td>4,181,500</td>
</tr>
<tr>
<td>P-Budget</td>
<td>Quantities</td>
<td>HY Paddy</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Tradable</td>
<td>Fertilizer (Rp/ha)</td>
<td></td>
</tr>
<tr>
<td>Net Profit</td>
<td>(including land) (Rp/ha)</td>
<td>2,681,500</td>
</tr>
</tbody>
</table>
Chapter 4: Social Benefit-Cost Analysis (The PAM’s Middle Row)

The second step in the empirical application of the Policy Analysis Matrix (PAM) is an assessment of revenues, costs, and profits in social (efficiency) prices. Data on social revenues and costs are entered in the middle row of the PAM, commonly called the “social row.” Figure 4.1 illustrates the entries for the middle row of PAM, which contains measures in social prices (prices that would result in the best allocation of resources and thus the highest generation of income). As mentioned in Chapter 2, the symbol E measures revenues in social prices, the symbol F stands for tradable input costs in social prices, the symbol G represents domestic factor costs in social prices, and the symbol H is social profit. Application of the profitability identity \( H = E - (F + G) \), introduced in Chapter 2, to social revenues and costs gives social profits. Countries achieve rapid economic growth by promoting activities that generate high social profits (large positive H).

**Figure 4.1. Social Profits in the Policy Analysis Matrix**

<table>
<thead>
<tr>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Factor</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>Social (efficiency) Prices</td>
<td>G</td>
<td>H</td>
</tr>
</tbody>
</table>

The purpose of this chapter is to explain how an analyst goes about the practical task of deciding what data to use in the middle (“social”) row of PAM and how to find that information.

The Social Valuation of Products

Whereas the compilation of budgets for the top row of PAM is the most time-consuming empirical task in PAM analysis, the estimation of social valuations for products and factors of production is the most challenging analytical task in project and policy analysis. Because the information needed for this task is vast and often impossible to find, social valuations can only be approximations. The key to successful PAM analysis is to be able to make reasonable approximations of social prices. If these estimates are good enough to convince policy makers and other economic analysts of their quality and applicability, they will place credence in the calculations of social profitability (efficiency), given by H in PAM, and of divergences (policy transfers and market failures), given by I, J, K, and L in PAM). The central goal is to explain carefully how these social valuations are estimated and to stress that they, by their nature, must be rough approximations.

**Social Prices for Tradable Outputs and Inputs**

Guidelines for the empirical estimation of the prices of tradable goods are identical for importables and exportables and for outputs and inputs.\(^{21}\) The private prices of tradable

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\(^{21}\) Social pricing of tradable inputs and outputs is discussed in *PAM*, pp. 189-196.
commodities (for the top row of the Policy Analysis Matrix) are found in the farm budgets from actual market prices at the farmgate, as discussed in Chapter 3. The counterpart social prices are border prices (comparable import prices for importables and export prices for exportables).

The social (or efficiency) prices of tradable commodities are given by comparable world prices because the import or export price is the best measure of the social opportunity cost of the commodity. For an importable, the import price indicates the opportunity cost of obtaining an additional unit to satisfy domestic demand. For an exportable, the export price is a measure of the opportunity cost of an additional unit of domestic production since that unit would be exported, not consumed domestically.

Many international commodity markets are heavily influenced by agricultural price policies, especially those in industrialized economies (the European Union, Japan, and the United States). These world markets thus do not operate efficiently from the point of view of allocating global resources to their best advantage. Agricultural protection and subsidization in rich countries create excess supplies and force world commodity prices downward to levels substantially below what they would be in the absence of policies. But even these distorted international prices provide a useful approximation of the social opportunity cost of importables or exportables in a developing country like Indonesia. If the other countries’ policies are not expected to change in the foreseeable future, the policy-affected world prices still represent the opportunity costs of Indonesian import substitution or export promotion. In this perspective, efficiency for Indonesia is a national concept, not a global one, since Indonesia’s policies only directly affect domestic prices and not international prices for nearly all tradable commodities.

The world price in domestic currency units is equal to the world price in foreign currency times the foreign exchange rate (the conversion ratio given in domestic currency units to foreign currency units). Hence, both the world price in foreign currency and the exchange rate are required to calculate the world price in domestic currency. If the analysis is addressing the issue of long-run efficiency (or international comparative advantage), it is appropriate to use long-run trend measures of both the world price (in foreign currency) and the exchange rate. Alternatively, if the study is looking at the historical experience of a recent period (for which the data for the PAM were gathered), it is appropriate to use recent historical data for both world prices (in foreign currency) and the exchange rate.

How can PAM analysts find data on comparable world prices for tradable outputs and inputs? The first place to look is in published international trade statistics. If appropriate world prices are not available from the country’s own statistical bureau, they might be found in trade data published by neighboring countries, industry groups, or international organizations (the International Monetary Fund, the World Bank, the Asian Development Bank, or United Nations agencies). In the rare cases when world prices cannot be found directly, it is sometimes possible to estimate them indirectly. If there are no market failures and all policies are known and readily measurable, the researcher can adjust the observed private prices (in entries A and B of PAM) for the effects of divergences (entries I and J) and find the social prices (E and F) as residuals. From the divergences identity, it is known that \((A - E = I)\) and \((B - F = J)\) and so also \((E = A - I)\) and \((F = B - J)\). But this procedure can only be done if the effects of divergences, I and J, are measurable, i.e., if there are no quantitative restrictions affecting trade.
When finding comparable world prices for tradable outputs and inputs, PAM researchers need to take into account three dimensions—location, time, and quality (or form)—of the commodity. The comparison of a domestic price with a world price must be done at an identical location (e.g., the nearby wholesale market), over the same time period (e.g., the main harvest season), and with a comparable quality of product (e.g., 25 percent broken rice). Otherwise, the prices will not be comparable because of errors introduced by transportation costs (different locations), the costs of or returns to storage (different time periods), and the costs of processing (different qualities or forms of the product). Transformations over location, time, and form are the three roles of agricultural marketing. Comparisons of domestic with world prices of tradables thus need to be done at an identical point in the marketing chain.

If divergences are not important in post-farm activities (farm-to-processor transportation, processing, and processor-to-whole-market transportation), it is convenient to collapse the four activities of the PAM into one and thus to carry out the domestic and world price comparisons at the farmgate level. For this purpose, the researcher needs to find the import parity prices for goods that substitute for imports and the export parity prices for goods that enter export markets. For import parity prices, the costs of domestic transportation and handling are added to the import price at the port, because the imports would have to be moved from the port to the nearby wholesale market to compete with local production. But for export parity prices, the costs of domestic transportation and handling are subtracted from the export price at the port, because the domestic production would have to be moved from the nearby wholesale market to the port before it could be sold abroad.

Table 4.1 provides an example of the calculations used to compute the social import parity price of paddy. The calculation of that price begins with the fob (free on board) export price in the exporting country (e.g., $150 per ton of 25 percent broken rice in Bangkok, Thailand). To find the cif (costs, insurance, freight) import price in a domestic port, one adds international freight and insurance costs (e.g., $15 per ton of rice from Bangkok to Jakarta, Indonesia). That cif Jakarta cost in US dollars is then converted into local currency with an appropriate exchange rate (e.g., Rp 9000/US$1). If the calculation hereafter is to be carried out in kilograms rather than tons, that conversion is made. Transportation and handling costs from the port to the nearby wholesale market are added to move the product to that location. Because the desired farmgate price is in a different product form, paddy not milled rice, a processing conversion factor is used to convert from milled rice to paddy (e.g., 1 kg paddy = .64 kg milled rice). Corrections also have to be made for milling costs, losses, and moisture content. The last step is to add transportation costs from the processor to the farmgate. Additional procedures and illustrations for calculating import parity and export parity prices are spelled out in the computer tutorial that accompanies this book.

<table>
<thead>
<tr>
<th>Table 4.2. Adjustment of International Prices to Farmgate Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.o.b. Thailand ($/ton)</td>
</tr>
<tr>
<td>Freight &amp; Insurance ($/ton)</td>
</tr>
<tr>
<td>C.i.f. Indonesia ($/ton)</td>
</tr>
<tr>
<td>Exchange rate (Rp/$)</td>
</tr>
<tr>
<td>Exchange rate premium (%)</td>
</tr>
</tbody>
</table>
The process behind the import parity price computations in the table is illustrated in Figure 4.2. Similar calculations are required for tradable inputs such as fertilizer, chemicals, and fuel.

**Figure 4.2. Adjustment of International Rice Prices to Farmgate Level**

1. Price converted at official exchange rate. (9,000 Rp/$)
2. Tons converted to kgs (1 ton = 1,000 kgs.) Price = Rp 1,530/kg
3. Transportation and handling to inland wholesale market Rp 133/kg.
4. After applying processing conversion factor (64%) Rp/kg = 1,014
5. Rice milling = Rp/kg 50

---

**Social Prices for Nontradable Outputs**

Different guidelines are proposed for the empirical estimation of the prices of nontradable commodities. As with tradables, the private prices for nontradables are taken from the private budgets at the farmgate level. But no border prices exist to serve as efficiency valuations for nontradables. Hence, the social prices of nontradable outputs are estimated by correcting their private prices for divergences (distorting policies and market failures).
Sometimes it is very difficult to estimate the social prices for nontradable commodities. The first step is to correct the private prices of nontradable outputs for identifiable divergences. As noted above for tradable products, the researcher tries to adjust the observed private prices (A and B) for the effects of divergences (I and J) and thus find the social prices (E and F) as residuals. Often, however, the effects of divergences, especially of market failures and sometimes also of distorting policies, are nearly impossible to measure. If the effects of divergences cannot be estimated, the next step is to search for the price of a close substitute commodity to use as a proxy for the social price of the nontradable commodity. If that search fails, the last step is to seek the price of the same commodity (or a close substitute) in a neighboring country.

**Decomposition of Nontradable Input Costs**

Nontradable input costs cannot be inserted directly into separate columns of a PAM, because there is no direct way of assigning social valuations to this category of costs. There are no comparable world prices for nontradable inputs. The desired solution is to decompose these costs, that is, to disaggregate the cost of producing the nontradable goods or services into their underlying tradable input costs and domestic factor costs (skilled and unskilled labor, capital, and land). Where possible, all nontradable intermediate input costs are allocated among these four PAM categories of costs, and this decomposition is done in both private and social prices.22

But this decomposition procedure, straightforward in principle, can be extraordinarily time-consuming in practice. It involves carrying out full PAM analyses of nontradable products and services (e.g., electricity) and thereby diverts the researchers’ attention from agricultural policy. To conserve scarce research resources, separate budgeting exercises to disaggregate nontradable costs should be avoided unless a nontradable input makes up more than 5 percent of total costs of production. Two time-saving approaches can be employed to make rapid approximations in disaggregating nontradable input costs. The first is to use input-output matrices of the national income accounts to allocate labor and capital shares of nontradable inputs in private prices. Land costs are ignored, and the residual is allocated to tradable input costs. The analyst then adjusts the private cost estimates to obtain social approximations. The second, a last resort if no input-output table is available, is to employ an operational rule of thumb and allocate one-third of nontradable costs each to the capital, labor, and tradable input cost categories. If the need to make these kinds of arbitrary allocations is widespread, the researcher will need to return to the field for additional information.

**The Social Valuation of Factors of Production**

For convenience in teaching the PAM approach, all of the costs of primary domestic factors of production – wage, interest, and land rental costs – are considered together in the matrix column titled domestic factor costs.23 However, each factor market and sub-market is studied separately in the empirical application of PAM. In practice, there are separate columns of data entries for each type and quality of factor (e.g., skilled male labor).

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22 The decomposition of nontradable input costs is discussed and illustrated in *PAM*, pp. 145-149, and in the computer tutorial that accompanies this book.

23 Factor markets in the Policy Analysis Matrix are analyzed and illustrated in *PAM*, Chapter 4, pp. 57-74. Factor markets and policies affecting them are further discussed in *FPA*, Chapter 5, pp. 234-247.

38
**Approach to Studying Factor Markets**

Domestic factor costs are treated differently from tradable input costs because there are no international prices for domestic factors that appropriately establish their social opportunity costs. A portion of some domestic factors, such as labor and capital, is mobile and receives employment abroad. But the opportunity costs of these factors are set in domestic markets, not in international markets. Wage, interest, and land rental rates are determined mostly by domestic supply and demand for factors, not by opportunities to employ factors overseas. Factors thus are not fully tradable internationally, and there are no international factor prices that can serve as good approximations of domestic opportunity costs.

This absence of world prices for factors means that social (or efficiency) prices for factors have to be approximated. The approach used in PAM analysis is to find the social prices of factors by adjusting the observed private prices for divergences. Field researchers study each rural factor market to search for the presence or absence of divergences – effective distorting policies or significant market failures. Hence, the entry for factor divergences (K) becomes a research input, which then is used to estimate social factor prices from observed private factor prices, as noted in Chapter 2.

In PAM analysis, therefore, social factor prices (G) are found by adjusting private factor prices (C) for observed divergences causing factor price transfers (K). Because the divergences identity requires that \((C – G) = K\), it is also true that \((C – K) = G\). In empirical application of PAM, the entries for G cannot be observed directly or found by using international prices. Hence, the entries for C and K are research inputs and those for G are research results. Factor Costs in the PAM are illustrated in Figure 4.3.

**Figure 4.3. Factor Costs in the Policy Analysis Matrix**

<table>
<thead>
<tr>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Factor</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td>G</td>
</tr>
<tr>
<td>Effect of Divergences</td>
<td></td>
<td>K</td>
</tr>
</tbody>
</table>

**Fragmentation in Factor Markets**

Fragmentation is the separation of factor sub-markets caused by immobility of factors or lack of free exit and entry. When fragmentation occurs, a factor sub-market is not well integrated and differing factor prices are observed from one fragment of the market to another. In seeking to find the extent of factor transfers (K), the PAM researcher’s task is to identify the causes of factor market fragmentation.

All factor markets are fragmented to some degree, by geography or types of actors. Some fragmentation is immutable. Regional land markets differ by distance from urban centers or ports, agro-climatic zone, soil quality, and slope of land. In some regions land has higher agricultural productivity than in others. Differing land rental rates reflect these physical
differences and agricultural productivities and are not necessarily indicative of imperfections in the land markets.

Other fragmentation is caused by factor market failures. In rural areas of developing countries, institutions to assist the provision of factor services often are in short supply or entirely missing. Imperfect capital markets, for example, arise when banks or other providers of financial intermediary services are poorly represented in rural areas. In other instances, the lack of reliable information networks cause factor markets to fail to operate efficiently. Rural laborers seeking daily work need to know where employment can be found.

Much fragmentation is caused by distortions, policies that cause the costs of factors to be higher (taxing factor use) or lower (subsidizing factor use) than their efficient, market-determined costs. Some governments in developing countries enact regulations to set ceilings (usually for interest rates) or floors (usually for wage rates) for factor prices in hopes of speeding development or redistributing income. Other governments tax or subsidize factor use. Legislated employer contributions to pension or health care plans for their employees increase the costs of hiring labor and tax labor use. Subsidized interest rates decrease the cost of borrowing capital for those who benefit from them.

The concept of fragmentation is useful for empirical study of factor markets. The researcher begins by separately considering each factor market and its sub-markets (e.g., skilled and unskilled, male and female laborers constitute four sub-markets within the labor market). Next within each factor sub-market, the researcher looks for the causes and extent of fragmentation. If fragmentation is immutable, such as within regional land markets, it is noted but not included as a source of divergence in land rental rates. Other fragmentation can be caused by divergences – market failures or distorting policies. The often complicated task for the field researcher is to try to sort out how much of the observed fragmentation is due to market failures – lack of institutions or information – and how much is due to distorting government policies – regulations or taxes/subsidies.24

**Factor Price Determination**

The demand for factors of production is mostly a derived demand. Some factors are hired directly by people who benefit from the factor services, but most factors are used in the production of other goods and services. Therefore, the demand for factors varies with changes in factor and output prices and with the productivity of factors in production processes. Firms demand factor services only to the extent that it is profitable for them to employ the factors. Higher factor prices thus translate immediately into lower demand by firms for the services of the more costly factors.

The supply of factors is determined by individual decisions of factor owners to provide factor services. Each individual capable of providing labor or management skills establishes how much he or she will be willing to work at various rates of remuneration (known as the labor-leisure trade-off). Owners of capital (savers) decide how much they will save and make available to others (borrowers) at various rates of interest. Similarly, owners of land decide how

24 An illustration of factor transfers in a Portuguese wheat system is given in *PAM*, pp. 232-233 and Box 12.4, p. 234.
much land they will rent out according to the rental rates they will receive. In all three instances, more factor services will be offered at higher rates of return for those services.

Price determination in factor markets then takes place in a manner similar to that discussed for goods (summarized in Chapter 5). The factor market is in equilibrium when the amount of factor services offered at a given factor price equals the amount of those services demanded at that price. Price formation thus is a simultaneous process determined by the joint actions of the willingness of factor owners to provide factor services and the desire of firms and others to hire those factors. The factor price will be determined efficiently unless the market is fragmented by the presence of market failures or distorting policy.

**Estimation of Factor Prices**

The social (efficiency) prices for domestic factors of production (land, labor, and capital) are estimated by application of the social opportunity cost principle. Because domestic factors are not tradable internationally and thus do not have world prices, their social opportunity costs are estimated through observations of rural factor markets. The intent is to find how much output and income are foregone because the factor is used to produce the commodity under analysis (e.g., rice) rather than the next best alternative commodity (e.g., sugarcane).

The empirical estimation of social prices of factors of production involves making a series of educated guesses. The estimated parameters are at best approximations. Formal modeling procedures cannot give reliable estimates for developing countries.

The process of approximating social factor prices begins by observing and collecting private market prices for each type and quality of factor of production used in the agricultural system under analysis. These data on private factor prices then are entered in box C in the PAM.

The next step is to identify the extent of fragmentation of factor markets and its causes – natural (immutable), market failure (changeable with institutional development), and distortion (policy-induced). Fragmentation results if the prices for one type of factor differ across sub-markets. PAM field researchers need to compare prices for the same type and quality of factor across separated (fragmented) markets to identify the extent of fragmentation.

Important evidence of the existence or lack of market failures is obtained by checking the degree of freedom of entry or exit of factors in the fragmented markets. If providers of factor services can easily move into and out of sub-markets, it is unlikely that monopolies or monopsonies are responsible for the differing factor prices.

If market failures do not seem to be causing the fragmentation, the divergence must be caused by distorting policy. The researcher then searches for the existence of enforceable policies that would cause the market fragmentation. After identifying the market failures and distorting policies (the entries in K in the PAM), the social factor prices (G) are found by adjusting the observed private factor prices (C) for the divergences (K), since G = (C – K).
**Estimation of Private and Social Wage Rates**

To compile detailed farm budgets, PAM researchers classify labor into categories according to gender (female or male), age (child or adult), and skill level (unskilled, semi-skilled, skilled, or managerial). The key issue is whether labor productivity differs enough between categories to cause differences in equilibrium wage rates. The observed data on private wage rates (multiplied by the labor input coefficients) are then entered into box C in the PAM.

The next step is to search for the existence or lack of market failures and of policy distortions in each labor sub-market. Quantitative estimates of these divergences are then entered in box K of the PAM as a research input.

Two types of market failures that might affect rural labor sub-markets in developing countries are monopsonies or oligopsonies (where one or a few large hiring firms collude to depress wage rates) and trade union power (where an organized group of workers legally forces wages upward). Easy entry and exit of laborers in each sub-market is strong evidence of the ineffectiveness of market power exercised by either hiring firms or trade unions.

Two types of distorting policies that might affect rural labor sub-markets in developing countries are minimum wage laws and pension and health insurance taxes (where the government requires employers to contribute to their employees’ pension and health plans and thus raises the cost of hiring labor). These kinds of policies are widespread in developing and developed countries, but they often are not well enforced in agriculture (except in plantations and processing plants). Policies that do not change labor costs, because they are not widely enforced, are ineffective and can be ignored in PAM analysis.25

**Estimation of Private and Social Interest Rates**

Both private and social interest rates need to be estimated in PAM analysis. During each interview with a farmer, trader, or processor, it is desirable to seek information on sources of credit and on the private interest rates paid with each credit source. Four sources of agricultural credit, and four corresponding levels of private interest rates, are commonly found in developing countries.

1) Farm household savings, from on-farm and off-farm activities, often provide most finance in farming because they usually are the lowest cost. Savings reflect foregone consumption or investment. The opportunity cost of self-financing production from household savings is thus the amount given up by not earning interest in a savings account.

2) Formal credit market institutions, such as commercial and government banks and other financial institutions, typically offer relatively little lending to small-scale farmers and traders, although their interest rates are moderate. These institutions are under-represented in rural areas and have high collateral requirements.

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25 Estimation of social wage rates is discussed in *PAM*, pp. 203-207 and illustrated for Portuguese agriculture in Box 11.3, pp. 206-207.
3) Kiosk-owners and other traders that sell fertilizer and related agricultural inputs often are an important source of credit for farmers, although with quite high interest charges. Informal credit flows between farmers, on one side of the transaction, and traders or suppliers of labor services, on the other, can vary across seasons so that farmers are borrowers in one part of the year and lenders in another.

4) Local money-lenders generally are the most expensive source of agricultural credit. Because their interest charges can exceed 10 percent per month, farm households avoid money-lenders for agricultural production and use them mostly in family emergencies.

Some governments offer subsidized agricultural credit. The subsidized interest rates are rarely representative of the private interest rates facing farmers because the subsidy programs typically fail to reach most farmers. PAM field researchers need to ascertain the effectiveness of subsidized credit programs to judge the rate of subsidy for representative farmers in the agricultural systems under study (and thus the entry in box K in the PAM).

Capital costs in PAM analysis are classified into two categories – working capital and investment capital. Working capital is the finance that a farmer, trader, or processor needs to cover cash costs of production (purchased inputs, hired labor, storage) within a production year. Investment capital refers to expenditures on assets that provide productive services for periods longer than one year. With investment capital, costs are incurred in one (or a few) year(s) but benefits (or productive services) are spread over a number of future years.

Capital market failures are usually widespread in developing countries because of the shortage of financial institutions in rural areas. The observed private interest rates, listed above, thus typically are a poor approximation of the social interest rates even if the government does not intervene with distorting policies, such as rural credit subsidies or interest rate ceilings.

Because of the complexity of possible market failures and distorting policies affecting rural credit markets, it is virtually impossible to measure the extent of these divergences. In PAM analysis (and in most other applications of social benefit/cost analysis), researchers are forced to adopt a different approach to estimate social interest rates. In principle, the social return to capital is represented by the rate of return on the next public or private investment that would be undertaken with additional investment funds. In practice, to estimate the social rates of interest for working capital and for investment capital, PAM researchers use an arbitrary rule of thumb – the experience of other developing and developed countries when they were at similar levels of development as the country in question.\(^{26}\)

**Estimation of Social Land Rental Rates**

Land is a fixed factor in agricultural production. Unlike labor and capital, which are mobile and can move to alternative activities, land is immobile. Unless the land happens to be

\(^{26}\) Estimation of social interest rates is discussed in *PAM*, pp. 200-203 and illustrated for Portuguese agriculture in Box 11.2, pp. 204-205.
located near an urban center and has residential or industrial uses, the opportunity cost of land planted to one crop (or cropping rotation) depends on its value in growing the next best alternative crop. Farmers allocate their land according to the relative profitability of various crops (along with household food needs and risk). The value of agricultural land in land sales markets or in land rental markets depends on its productivity and hence its profitability for farmers who might buy or rent in the land.

The social valuation of land follows the social opportunity cost principle. From the point of view of the national economy, the social land rental rate is found by estimating the social profit (H) of the land in its best alternative use when all costs of land are excluded. For example, the social cost of using a plot of land to grow rice in one season is found by estimating the foregone social profit from not planting that land to the next most profitable crop (e.g., sugarcane). However, this approach requires the researcher to identify the best alternative crop and to carry out a full PAM analysis on it.

If it is not practical to study the alternative crops that might substitute for the crop of primary interest, a different approach can be taken in PAM analysis. Profitability is re-defined to include returns to land and management (rather than only returns to management). Land costs then are omitted from both private and social calculations. Because of the difficulty and expense of studying alternative crops to estimate social land rental rates, many PAM analysts adopt this modified approach.27

**Factor Price Estimation for Indonesian Agriculture**

Estimation of social factor prices can be illustrated with reference to an ongoing series of PAM analyses of Indonesian agriculture carried out by researchers from the Center for Agro-Socio Economic Research in Bogor, Indonesia (CASER).28 A comparative PAM study of rice systems in Indonesia was carried out in the late 1980s by Stanford University’s Food Research Institute.29

Both the Stanford and the CASER studies find minimal divergences affecting rural labor markets in Indonesia. Distortions are insignificant, because the minimum wage legislation is not enforced in agriculture and has limited impact elsewhere in the Indonesia economy. Fragmentation across labor sub-markets is minor, because of free entry and exit across sub-markets, good information on job opportunities, and widespread use of labor contractors. Therefore, the private wage rates for all categories of rural labor are good approximations for the social wage rates (in PAM terms, K is minimal, so G about equals C).

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27 Estimation of social land rental rates is discussed in *PAM*, pp. 207-209 and illustrated for Portuguese and Mexican agriculture in Box 11.4, pp. 210-211.


29 The results of that study are reported in *RPI*, Chapter 7, pp. 115-120, 131. An empirical study of the rural labor market in Indonesia by Rosamond Naylor is found in *RPI*, Chapter 5, pp. 58-85.
This conclusion does not hold true in the urban labor markets in which much of the post-farm processing and marketing take place. The wage rates for all categories of labor in the urban markets are influenced by two kinds of policy distortions, although not importantly by market failures. Minimum wage legislation is enforced in urban markets. But the distortions are very small since the minimum wage rate is not much different from the comparable market wage rate. In the urban labor markets, social legislation (for pensions and medical insurance) is enforced and causes somewhat higher labor costs. Adjustments thus are made for these distorting policy impacts (in PAM terms, K is slightly positive, reflecting a small tax on labor, so G is less than C).

The CASER and Stanford studies also provide current and historical estimates of social prices for capital and land in Indonesian agriculture. For capital investment, the private interest rates vary widely (among different financial intermediaries, types of borrowers, and locations). Based on the experience of other countries at comparable stages of development, the social interest rate for capital investment in Indonesia is likely to be about 10-15 percent per annum (plus the rate of inflation). For working capital, the private interest rates also vary widely. From other countries’ experiences, the social interest rate for working capital in Indonesia is likely to be about 15-20 percent per annum (plus the rate of inflation).

The private land rental rate in Indonesian agriculture differs according to land quality and location (usually reflecting the private profitability of farming). Where possible, the social land rental rate is found by valuing land at the social profitability of the next best alternative crop (or cropping rotation). Otherwise, land costs are excluded from the estimation of both private and social profitability and private and social profits are re-defined to include the returns to land and management.

**Tutorial Example of Social Profitability**

The calculation of social profitability for the illustrative high-yielding rice system in Indonesia is also presented in the accompanying computer tutorial. Like the estimate of private profitability, that for social profits proceeds in three steps. For most PAM applications, the assumption is made that the input-output coefficients are identical for both private and social analyses. Hence, the input-output data reported above in Table 3.1 are used also in the calculation of social costs and returns.

The challenges in social analysis thus arise in finding appropriate social prices for all inputs and products. For tradable inputs and outputs, the key issues are assessing the comparable import or export prices in foreign currency, converting those prices with a suitable exchange rate, and adjusting the domestic currency prices to the farm-gate level. This process of conversion and adjustment for form, time, and location was illustrated above for paddy output in Table 4.1 and Figure 4.2. The full set of social prices for the illustrative paddy system is presented in Table 4.2.

<table>
<thead>
<tr>
<th>Table 4.2. Social Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S-Prices</strong></td>
</tr>
<tr>
<td>Tradable</td>
</tr>
<tr>
<td>Urea</td>
</tr>
<tr>
<td>SP-36</td>
</tr>
</tbody>
</table>
As in the creation of a private budget, the final step in creating a social budget is to multiply the quantities in the input-output table (Table 3.1) times the efficiency prices in the social prices table (Table 4.2). The resulting values become the entries in the social budget table (Table 4.3). For this high-yielding rice system, social profit (returns to management and land) is 45 percent of social revenue and the social benefit-cost ratio (SBCR) is Rp 5,784,000/ Rp 3,163,500 or 1.8.

Table 3. Social Prices Budget

<table>
<thead>
<tr>
<th>S-Table 4.Budget</th>
<th>Quantities</th>
<th>HY Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradables</td>
<td>Fertilizer (Rp/ha)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urea</td>
<td>264,000</td>
</tr>
<tr>
<td></td>
<td>SP-36</td>
<td>140,000</td>
</tr>
<tr>
<td></td>
<td>KCl</td>
<td>32,000</td>
</tr>
<tr>
<td></td>
<td>ZA</td>
<td>150,000</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Liquid insecticides (Rp/ha)</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>Granulated insecticides (Rp/ha)</td>
<td>150,000</td>
</tr>
<tr>
<td></td>
<td>Seed (Rp/ha)</td>
<td>87,500</td>
</tr>
<tr>
<td></td>
<td>Fuel (Rp/ha)</td>
<td>97,500</td>
</tr>
<tr>
<td>Factors</td>
<td>Labor (Rp/hr)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seedbed Prep</td>
<td>160,000</td>
</tr>
<tr>
<td></td>
<td>Crop Care</td>
<td>960,000</td>
</tr>
<tr>
<td></td>
<td>Harvesting</td>
<td>320,000</td>
</tr>
<tr>
<td></td>
<td>Threshing</td>
<td>240,000</td>
</tr>
<tr>
<td>Capital</td>
<td>Working Capital (Rp/ha)</td>
<td>160,000</td>
</tr>
</tbody>
</table>

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### Table 4.3. Social Prices Budget

<table>
<thead>
<tr>
<th>S- Table 4.Budget</th>
<th>Quantities</th>
<th>HY Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tractor Services (Rp/ha)</td>
<td>250,000</td>
</tr>
<tr>
<td></td>
<td>Thresher (Rp/ha)</td>
<td>52,500</td>
</tr>
<tr>
<td></td>
<td>Land (Rp/ha)</td>
<td>-</td>
</tr>
<tr>
<td>Output</td>
<td>Total Revenue (Rp/ha)</td>
<td>5,784,000</td>
</tr>
<tr>
<td></td>
<td>Total Cost (excluding land) (Rp/ha)</td>
<td>3,163,500</td>
</tr>
<tr>
<td></td>
<td>Profit (excluding land) (Rp/ha)</td>
<td>2,620,500</td>
</tr>
<tr>
<td></td>
<td>Net Profit (including land) (Rp/ha)</td>
<td>-</td>
</tr>
</tbody>
</table>
Chapter 5: Policies and Market Failures (The PAM’s Bottom Row)

The types of results available from PAM analysis were introduced in the previous three chapters. Profitabilities follow from application of the profitability identity, whereas the effects of divergences are derived from application of the divergences identity. Private profitability, defined in PAM as \( D = A - (B + C) \), measures competitiveness in actual market prices. Social profitability, defined in PAM as \( H = E - (F + G) \), measures efficiency (or comparative advantage) in efficiency prices.

This chapter focuses on identifying and interpreting the effects of divergences.\(^{30}\) A divergence causes an actual market price to differ from a counterpart efficiency price. Divergences arise from either of two sources – market failures or distorting policies.

A market failure occurs if a market fails to provide a competitive outcome and an efficient price. Common types of market failures are monopolies, externalities, and factor market imperfections. A distorting policy is a government intervention that forces a market price to diverge from its efficient valuation. Taxes/subsidies, trade restrictions, or price regulations could lead to this result. Distorting policies usually are enacted to further non-efficiency objectives (equity or security).

Output Transfers in the Policy Analysis Matrix

A divergence in output prices, causing private revenues (\( A \)) to differ from social revenues (\( E \)), creates an output transfer (\( I = (A - E) \)). The output transfer (\( I \)) is illustrated in Figure 5.1. This divergence can be either positive (causing an implicit subsidy or transfer of resources in favor of the agricultural system) or negative (causing an implicit tax or transfer of resources away from the system).

For example, Indonesia currently imposes a tariff on rice imports, causing domestic rice prices to be about 25 percent higher than the world price (the efficiency price). This distorting policy creates a positive divergence (entry I in the PAM matrix), and the effect of the divergence is the difference between the domestic price (entry A in PAM) and the social (import) price (entry E in PAM). The tariff thus creates an implicit subsidy to rice production because it causes the domestic rice price to be higher than in the absence of policy. In this example, a part of the

divergence is caused by a rice traders’ risk premium and the remainder is due to the tariff on rice (as discussed in Chapter 1).

**Interpretation of Output Transfers**

The PAM entries for output transfers are \( I = (A - E) \). The unit used to denominate every entry in the PAM matrix is called a numeraire. All entries in a PAM, including measures of output transfers, are denominated in local currency units per kilogram (or per ton) of the primary commodity produced (and sold) for comparisons of agricultural systems producing one commodity. To compare rice production systems in Indonesia, for example, the numeraire would be Rupiah per kilogram of milled rice at the mill or Rupiah per kilogram of wet paddy (unmilled rice) at the farm gate.

Ratios, which are free of currency or commodity distinctions, are used to compare unlike outputs (e.g., rice and sugarcane). The ratio formed to measure output transfers is called the Nominal Protection Coefficient on Output (NPCO), a term taken from the literature on international trade. \( \text{NPCO} = A/E \). This ratio shows how much domestic prices differ from social prices. If NPCO exceeds one, the domestic price is higher than the import (or export) price and thus the system is receiving protection. If NPCO is less than one, the domestic price is lower than the comparable world price and the system is disprotected by policy. In the absence of policy transfers (i.e., if \( I \) equals zero), the domestic and world prices would not differ and the NPCO would equal one.

PAM analysts need to search carefully for the existence or absence of market failures – monopolies or externalities – affecting output markets. Past studies of agricultural systems in developing countries have found that significant market failures influencing outputs are rare. Monopolies that were found typically were established by government regulations.

Most output transfers, where they occur, have been caused by distorting policies. One source of distortions is price policy – trade restrictions or taxes/subsidies – enacted to promote non-efficiency objectives. A second source of output transfers comes from disequilibrium exchange rates arising from macro-economic policies that are not in balance. The efficiency prices for outputs are set by comparable world prices. Distorting price policy forces a departure of domestic prices from those efficiency prices, and inappropriate exchange rate policy means that the wrong conversion factor is used to convert world prices from foreign exchange to domestic currency.

**Example of Output Transfers**

An illustration of output transfers in the high-yielding Indonesian rice system is presented in Table 5.1.

<table>
<thead>
<tr>
<th>Revenues (rupiahs per hectare)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>7,230,000</td>
</tr>
<tr>
<td>Social</td>
<td>5,784,000</td>
</tr>
<tr>
<td>Divergences</td>
<td>1,446,000</td>
</tr>
</tbody>
</table>
Table 5.1. Example of Output Transfers

<table>
<thead>
<tr>
<th>Revenues (rupiahs per hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I A-E</td>
</tr>
<tr>
<td>NPCO A/E</td>
</tr>
<tr>
<td>1,446,000</td>
</tr>
<tr>
<td>1.25</td>
</tr>
</tbody>
</table>

In that example, the commodity system produced only one output – milled rice. The value of milled rice in private prices (Rp 7,230,000 per hectare) was about 25 percent higher than the value in social prices (Rp 5,784,000 per hectare). The output transfer (Rp 1,446,000 per hectare) was caused by a specific tariff of Rp 430/kilogram on rice imports, which resulted in a tariff-equivalent of 25 percent.

The Nominal Protection Coefficient on Output (NPCO) or A/E was 1.25. Because of the tariff on milled rice imports, the value of total output was 25 percent higher than it would have been in the absence of policy.

** Tradable Input Transfers in the Policy Analysis Matrix**

A divergence in tradable input prices, causing private tradable input costs (B) to differ from social tradable input costs (F), creates a tradable input transfer (J = (B – F)). The tradable input transfer within PAM is demonstrated in Figure 5.2. This divergence can be either positive (causing an implicit tax or transfer of resources away from the system) or negative (causing an implicit subsidy or transfer of resources in favor of the agricultural system).

**Figure 5.2. Tradable Input Transfers in the Policy Analysis Matrix**

<table>
<thead>
<tr>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Factor</td>
</tr>
<tr>
<td>Private</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Effect of Divergences</td>
<td>J</td>
<td></td>
</tr>
</tbody>
</table>

A subsidy on pesticides, for example, would mean that farmers would pay only (B), a portion of the full cost of pesticides (F). The government treasury would pay the remainder (J) as the pesticide subsidy. The entry, J = (B – F), would be negative (since B is less than F by the amount of the subsidy). A subsidy reducing input costs thus enters the PAM matrix as a negative entry in the Effects of Divergences row.

The opposite holds true for taxes on tradable inputs. A tax on fuel, for instance, would mean that fuel cost paid by farmers (B) would exceed the opportunity cost given by the world price (F) by the amount of the tax (J), and the entry, J = (B – F), would be positive.
**Interpretation of Tradable Input Transfers**

The PAM entry for tradable input transfers is \( J = (B - F) \). The interpretation of tradable input transfers is similar to that for tradable output transfers because both are based on comparisons of actual market (private) prices with world (social) prices.

Ratios, which are free of currency or commodity distinctions, are used to compare unlike tradable inputs (e.g., fertilizer and fuel). The ratio formed to measure tradable input transfers is called the Nominal Protection Coefficient on Inputs (NPCI), a term also taken from the literature on international trade. \( NPCI = B/F \). This ratio shows how much domestic prices of tradable inputs differ from their social prices. If NPCI exceeds one, the domestic input cost is higher than the input cost at world prices and the system is taxed by policy. If NPCI is less than one, the domestic price is lower than the comparable world price and the system is subsidized by policy. In the absence of policy transfers (i.e., if \( J \) equals zero), the domestic and world prices of tradable inputs would not differ and the NPCI would equal one.

A second ratio, the Effective Protection Coefficient (EPC), can be calculated directly using entries from the PAM matrix. This ratio compares valued added in domestic prices \((A - B)\) with value added in world prices \((E - F)\). \( EPC = (A - B)/(E - F) \). The purpose of the EPC is to show the joint effect of policy transfers affecting both tradable outputs and tradable inputs. The EPC is a variant of the Effective Rate of Protection (ERP), a common measure of trade distortions. \( ERP = (EPC - 1) \times 100\% \). \(^{31}\)

PAM analysts need to search carefully for the existence or absence of market failures—monopolies or externalities—affecting tradable input markets. Past studies of agricultural systems in developing countries have found that significant market failures influencing tradable inputs are rare. As in the markets for tradable outputs, most monopolies found were established by government regulations, not by private cartels.

Most tradable input transfers thus are caused by distorting policies. As with tradable outputs, two sources of divergences affect the prices of tradable inputs—price policies (trade restrictions or taxes/subsidies) and disequilibrium exchange rates.

**Example of Tradable Input Transfers**

An illustration of tradable input transfers in the Indonesian rice system is presented in Table 5.2. In that example, the rice system used three tradable inputs—fertilizer, chemicals, and other (seed and fuel).

![Table 5.2. Example of Tradable Input Transfers](image)

\(^{31}\) The Effective Protection Coefficient (EPC) for the Portuguese wheat system is calculated and interpreted in *PAM*, p. 232.
Table 5.2. Example of Tradable Input Transfers

<table>
<thead>
<tr>
<th>Tradable input costs (rupiahs per hectare)</th>
<th>Fertilizer</th>
<th>Chemicals</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-F</td>
<td>(55,000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPCI</td>
<td>B/F</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The cost of chemicals (insecticides and herbicides) in private prices (Rp 195,000 per hectare) was much less than the cost of chemicals in social prices (Rp 250,000 per hectare). The entire negative tradable input transfer (-55,500 per hectare) was caused by a subsidy on chemicals of about 28 percent.

For all tradable inputs, the total tradable input policy transfer (J) thus was –Rp 55,000 per hectare. The Nominal Protection Coefficient on Inputs (NPCI) was B/F or 195,000/250,000 = .78. Because of the subsidy on chemicals, the total cost of tradable inputs was only about 75 percent of what it would have been in the absence of policy.

Factor Transfers in the Policy Analysis Matrix

Divergences can influence the prices of domestic factors (skilled labor, unskilled labor, capital, and land). Factor market divergences cause private factor costs (C) to differ from social factor costs (G) and thus create a factor transfer (K = (C – G)). Factor transfers are illustrated in the PAM framework in Figure 5.3. As with divergences affecting tradable input costs, this factor divergence can be either positive (causing an implicit tax or transfer of resources away from the system) or negative (causing an implicit subsidy or transfer of resources in favor of the agricultural system).

Figure 5.3. Factor Transfers in the Policy Analysis Matrix

<table>
<thead>
<tr>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Factor</td>
</tr>
<tr>
<td>Private</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>Effect of Divergences</td>
<td>K</td>
<td></td>
</tr>
</tbody>
</table>

Interpretation of Factor Transfers

The PAM entry for factor transfers is K = (C – G). Divergences in factor markets result from both market failures and distorting policies.

Past studies of agricultural systems in developing countries have found that significant market failures influencing factor prices are common. Researchers thus should assume that factor markets are imperfect unless careful examination shows that private factor prices appear to be reasonable approximations of social factor prices. Approaches to identifying imperfections in factor markets are outlined in Chapter 4.
Factor transfers can also result from distorting policies. Distortions in labor and capital markets arise from taxes or subsidies (e.g., a pension tax on wages or a credit subsidy), price regulations (e.g., minimum wage floors or interest rate ceilings), or distorting macro-economic policies (e.g., inflationary monetary policy). Approaches to identifying policy distortions in factor markets are also outlined in Chapter 4.

**Example of Factor Transfers**

An illustration of factor transfers in the Indonesian rice system is presented in Table 5.3. In that example, the rice system used two factor inputs—labor and capital. Divergences in the market for unskilled labor in rural Indonesia were insignificant, as explained in Chapter 4. Hence, the private unskilled wage rate was assumed to be a good proxy for the social unskilled wage rate.

<table>
<thead>
<tr>
<th>Table 5.3. Example of Factor Transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor Costs (rupiahs per hectare)</strong></td>
</tr>
<tr>
<td><strong>Labor</strong></td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>Social</td>
</tr>
<tr>
<td>Divergences</td>
</tr>
</tbody>
</table>

The subsidy on capital costs was implicit rather than an explicit subsidy from the government treasury. The implicit subsidy appears because the social opportunity cost of working capital in the example was taken as 24 percent annually (8 percent per season) whereas the private annual interest rate for working capital was assumed to be only 15 percent (5 percent per season). The factor transfer on capital was a subsidy amounting to 15 percent of total capital costs, or Rp 60,000 per hectare. The net factor transfer was a subsidy of only 3 percent of total factor costs, because the credit subsidy was small relative to total costs.

**Net Transfers in the Policy Analysis Matrix**

Positive output transfers (I) create subsidies for an agricultural system (because they lead to higher revenues), whereas negative tradable input transfers (J) and factor transfers (K) denote subsidies (because they indicate reduced costs of production). Similarly, negative output transfers impose taxes on a system, whereas positive tradable input and factor transfers create taxes. The net transfer (L), shown in the PAM framework in Figure 5.4, is the sum of these positive and negative transfer effects on revenues and costs.

<table>
<thead>
<tr>
<th>Figure 5.4. Net Transfers in the Policy Analysis Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>Social</td>
</tr>
<tr>
<td>Effect of Divergences</td>
</tr>
</tbody>
</table>
Interpretation of Net Transfers

The net transfer, designated by entry L in the PAM, is found by applying either of the two PAM accounting identities. From the profitability identity, \( L = (I - J - K) \). The net transfer is the sum of output, tradable input, and factor transfers. From the divergences identity, \( L = (D - H) \). The net transfer explains the difference between private and social profits. If efficient policies exactly offset market failures and all distorting policies are removed, divergences disappear and the net transfer becomes zero. The net transfer also becomes zero if distortions in output prices are offset by equal and opposite distortions in input prices.

Calculation of two ratios assists the comparison of PAM results among agricultural systems that produce unlike commodities. The profitability coefficient (PC) measures the impact of all transfers on private profits. \( \text{PC} = \frac{D}{H} = \frac{A - B - C}{E - F - G} \). The PC ratio uses the same data as the calculation of net transfer, \( L = (D - H) \), and thus allows a comparison of net transfers among unlike systems. The PC also is an expansion of the EPC to include factor costs (along with revenues and tradable input costs).

The subsidy ratio to producers (SRP) is a single measure of all transfer effects. The SRP is the output tariff equivalent if the net effect of all policy transfers were carried out solely through a tariff on output. This ratio is a comparison of the net transfer to the value of output in world prices, or \( \text{SRP} = \frac{L}{E} \). The SRP indicates the extent to which the system’s revenues are increased or decreased because of transfers. If market failures are minor, the SRP shows the net impact of distorting policies on system revenues.

Example of Net Transfers

An illustration of the net transfer in the Indonesian rice system is presented in Table 5.4. In that example, the net transfer for the system and the summary ratios are calculated and interpreted.

<table>
<thead>
<tr>
<th>Table 5.4. Net Transfer, Profitability Coefficients, and Subsidy Ratios to Producers in Indonesian Rice Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>EPC</td>
</tr>
</tbody>
</table>
The rice system is socially profitable in the absence of policy (H = Rp 2,620,500 per hectare). The net transfer is the sum of all divergences (L = (I – J – K)) and also is the difference between private and social profits (L = (D – H)). The net transfer for the rice system, Rp 1,561,000 per hectare, is the sum of the output transfer (Rp 1,446,000 per hectare), caused by a specific tariff on rice, the tradable input transfer (Rp 55,000), resulting from subsidies on chemicals, and the factor transfer (Rp 60,000 per hectare), deriving from imperfections in the market for working capital. The net transfer also is the difference between private profits and social profits, or Rp 4,181,500 less Rp 2,620,500 = Rp 1,561,000.

The Profitability Coefficient (PC) for the system, the ratio of private profits to social profits, or PC = D/H, is Rp 4,181,500/2,620,000 = 1.6. The net transfer of Rp 1,561,000 permitted private profits to be more than one and one-half times greater than they would have been without policy transfers. Researchers thus need to discover why policy makers in Indonesia enacted policies to assist an agricultural system that was very profitable without the aid of policy transfers.

The Subsidy Ratio to Producers (SRP), the ratio of net transfer to revenues in social prices, or L/E, is Rp 1,561,000 per hectare/Rp 5,784,000 per hectare = .27. The net transfer could be created solely by a tariff on rice of 27 percent if all other divergences were eliminated. If there were no divergences affecting tradable inputs or factors, the NPCO would have to be increased only from 1.25 to 1.27 to maintain a net transfer equivalent to Rp 1,625,500. This result indicates that nearly all the subsidy to rice producers comes from the tariff on rice and very little is transferred from the subsidy on chemicals and the implicit subsidy on working capital costs.

Farming Systems PAM

The previous PAM was created under the assumption that the social opportunity cost of land could not be identified. However, in many areas of Indonesia, soybeans could be grown on land used for rice. Soybean profits therefore provide an opportunity cost for land that can be incorporated into a complete “farming systems” rice PAM. Table 5.5, the soybean PAM, is derived from the same budget analysis illustrated in Chapters 3 and 4.

Table 5.5. PAM for Soybeans

<table>
<thead>
<tr>
<th></th>
<th>Revenue</th>
<th>Tradable Inputs</th>
<th>Domestic Resources</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Private</td>
<td>Social</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,824,000</td>
<td>2,468,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>168,000</td>
<td>168,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>579,325</td>
<td>579,325</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>85,942</td>
<td>112,099</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,990,733</td>
<td>1,609,076</td>
<td></td>
</tr>
<tr>
<td>Divergences</td>
<td>355,500</td>
<td>-</td>
<td>-</td>
<td>(26,157)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>381,657</td>
</tr>
</tbody>
</table>

The farming systems PAM for rice (Table 5.6) requires the addition of a column that shows the price of land as derived from the profits of growing the next best alternative, soybeans. The virtue of the farming systems PAM is that it provides a quantitative estimate of the comparative advantage of a commodity from a farmer’s perspective. Positive profits for rice means, for example, that rice production is the optimal use of the farm’s resources.
Conversely, if the same exercise were carried out for the soybeans PAM, the substantial rice profits—and the resulting high land values—would produce negative profits for soybeans. Negative profits would indicate clearly that soybeans do not have a comparative advantage in the farming system from which the data are drawn.

Table 5.6. Farming Systems PAM for Rice

<table>
<thead>
<tr>
<th></th>
<th>Revenue</th>
<th>Tradable</th>
<th>Domestic Resources</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inputs</td>
<td>Labor</td>
<td>Capital</td>
<td>Land</td>
</tr>
<tr>
<td>Private</td>
<td>7,230,000</td>
<td>966,000</td>
<td>1,680,000</td>
<td>402,500</td>
</tr>
<tr>
<td>Social</td>
<td>5,784,000</td>
<td>1,021,000</td>
<td>1,680,000</td>
<td>462,500</td>
</tr>
<tr>
<td>Divergences</td>
<td>1,446,000</td>
<td>(55,000)</td>
<td>(60,000)</td>
<td>381,657</td>
</tr>
</tbody>
</table>

Multi-Period PAM

Previous PAMs have been based on seasonal crops. These dominate Indonesian agriculture. However, there are a number of commodities whose planting and harvesting takes place over time. Examples include such crops as rubber, cloves, and vanilla, as well as investments in livestock production.

Computing PAMs for commodities that stretch over a number of periods requires constructing a PAM for each period, then computing the net present value of the entire series. Discounting is necessary because the value of future costs and returns is less than the value of costs and returns measured in the present. The fact that alternative returns to revenues and expenditures—their opportunity cost—increases at a compound rate, e.g., bank account deposits, needs to be accounted for in the multi-period PAM.

The formula for computing the NPV for revenue is:

\[ NPV_R = \sum_{i=1}^{n} \frac{R_i}{(1+i)^t} \]

where \(i\) is the discount (interest) rate and \(t\) is the number of time periods over which the commodity is grown.

Table 5.7 shows the budgets for vanilla over the 10-year period that comprises the normal production cycle. In the first two periods, the crop requires inputs and resources, but yields no revenues. Output increases until the 5th year when the crop reaches maturity. After than, output declines until the 10th year when the vanilla is hardly worth harvesting.

Table 5.7. Multi-period Vanilla Budgets (Private Prices in Rps 000,000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenue</th>
<th>Tradable Inputs</th>
<th>Domestic Factors</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Interest rate</td>
<td>Labor Capital</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
<td>15%</td>
<td>5.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
<td>0.6</td>
<td>6.0</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>16.0</td>
<td>0.9</td>
<td>9.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
The second row of the multi-period PAM (social prices) is computed using the same methodology. The NPV’s for revenues, inputs, and domestic resources are then organized in the traditional PAM format. The multi-period PAM results indicate the total profits and the total policy and market related divergences for the period, all discounted by an interest rate.

Table 5.8. Multi-period Vanilla PAM (Rps. 000,000)

<table>
<thead>
<tr>
<th></th>
<th>Revenue</th>
<th>Tradable Inputs</th>
<th>Domestic Factors</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Labor Capital</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>93</td>
<td>6</td>
<td>36   8</td>
<td>43</td>
</tr>
<tr>
<td>Social</td>
<td>75</td>
<td>5</td>
<td>32   9</td>
<td>28</td>
</tr>
<tr>
<td>Divergence</td>
<td>18</td>
<td>1</td>
<td>4     (2)</td>
<td>15</td>
</tr>
</tbody>
</table>

The multi-period PAM is interpreted in the same way as a single-period PAM. Table 5.6 shows that producers are receiving substantial subsidies through government policies, either in the direct purchase of the crop from trade policy that affects the output price.
Chapter 6. Benefit-Cost Analysis

The farm budgets and PAM analyses presented in previous chapters were used to determine the profitability and efficiency of Indonesian rice systems. With some additions to the database used in Chapters 3 and 4, this same PAM methodology can be used as a point of departure for evaluating the economic feasibility of capital investments. Two pieces of additional information are needed – the effect of the capital investment on the input-output relationships in a rice production system and the cost of the investment.

Benefit-Cost Analysis in the PAM

To compute the benefit-cost (B-C) ratio for an investment in an Indonesian rice system, a policy analyst follows four steps:

1. Gather data on technical relationships to construct two input-output tables, one representing a production system without the project, the other with the project. Using the existing private and social prices, compute two PAMs to represent the with and without conditions.

(The budgets and PAMs constructed in previous chapters are assumed to represent production in an area that has good water control. These data therefore represent estimates of the increased output that would be forthcoming with the project. The without project data are assumed to come from an area with poor water control that is being considered for an irrigation project.)

2. Estimate the components and then the total cost of the investment in private and social prices.

3. Subtract the (private and social) profitability of the without project PAM from the (private and social) profitability of the new PAM to determine the incremental (private and social) benefits generated by the investment.

4. Divide the incremental benefit of the investment by its cost, both properly discounted, to determine the benefit-cost ratios at both private and social prices. Benefit-cost ratios greater than one indicate that implementing the project would be profitable.

These four steps are illustrated below, first in a single-period framework where benefits and costs occur in the same year, then in a multi-period framework where benefits and costs occur over time. The presence of time requires that the elements of the analysis be discounted to reflect the fact that rupiahs earned or paid in the present are worth more than amounts earned or paid in the future. (A rupiah earned in the present can be deposited in a bank to earn interest; hence it is worth more than one obtained in the future, which cannot.)

---

The formula for discounting a single element is:

$$\frac{\Delta D}{(1+i)^t}$$

where $\Delta D$ = the difference between the profitability of the two PAMs, $i$ = the discount rate, and $t$ = the time elapsed since the start of the project. Amounts that occur when $t$ is small (early in the project) will be discounted less heavily than when $t$ is large (late in the project). Typically, costs, which usually appear at the beginning of a project’s net benefit stream, are discounted less heavily than benefits, because benefits are generated well into the future. This means that if projects are dragged out and not completed in a timely fashion, the realized benefit-cost ratio can be much lower than the one estimated by planners.

**Single-Period Benefit-Cost Analysis**

The PAM for the poor water control system reflects what is known in the project appraisal literature as the “without project” case. It shows what would happen if there were no intervention in the farming system. The second “with project” PAM, indicated by primes on the symbols of Table 6.1, incorporates the effects of changes in yields that would result from the application of additional fertilizer or chemical inputs. Figure 6.1 illustrates the calculation of a single-period benefit-cost B-C ratio for the use of inputs such as fertilizers and chemicals. In the single-period example, both the investment and the returns to the investment occur in the same year.

Incremental benefits from the investment are obtained by subtracting the private and social profitabilities of the without project PAM from those of the with project PAM, resulting in $\Delta D$, the change in private profitability, and $\Delta H$, the change in social profitability. These incremental benefits are the numerators of the benefit-cost ratios, the costs of the fertilizer and chemicals, measured in private and social prices, are the denominators. (The private benefit-cost ratio thus is $\Delta D/i^p$ and the social benefit-cost ratio is $\Delta H/i^s$.)

<table>
<thead>
<tr>
<th>Table 6.1. Single-Period Benefit-Cost Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private Calculations</strong></td>
</tr>
<tr>
<td>Revenues</td>
</tr>
<tr>
<td>Costs</td>
</tr>
<tr>
<td>Profits</td>
</tr>
<tr>
<td>Investment</td>
</tr>
<tr>
<td>Input Factors</td>
</tr>
<tr>
<td>Costs</td>
</tr>
<tr>
<td>B-C Ratio</td>
</tr>
<tr>
<td>With Project</td>
</tr>
<tr>
<td>Without Project</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Social Calculations</strong></td>
</tr>
<tr>
<td>With Project</td>
</tr>
<tr>
<td>Without Project</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

A numerical example of a single-period benefit-cost calculation, using the PAM results generated in Chapter 5, is reported in Table 6.1. An investment of Rp 500,000 in short-term
inputs, such as fertilizers, fuel, seeds, chemicals, are assumed to yield an increase in output of 1,000 kg/ha. The resulting incremental net revenue in private prices is Rp 1,205,000, and the single-period benefit-cost ratio is 2.41. In social prices, the incremental net revenue is Rp 964,000 and the benefit-cost ratio is 1.93. The difference in the two benefit-cost ratios is caused by the trade policies and subsidies discussed in Chapter 5.

Table 6.2. Single-Period Benefit-Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Private Calculations</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Revenues</td>
<td>Costs</td>
<td>Profits</td>
<td>Investment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input</td>
<td>Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Project</td>
<td>7,230,000</td>
<td>966,000</td>
<td>2,082,500</td>
<td>4,181,500</td>
<td></td>
</tr>
<tr>
<td>Without Project</td>
<td>6,025,000</td>
<td>966,000</td>
<td>2,082,500</td>
<td>2,976,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,205,000</td>
<td>500,000</td>
</tr>
</tbody>
</table>

| Social Calculations    |                      |                      |                      |                      |                      |
| With Project           | 5,784,000            | 1,021,000            | 2,142,500            | 2,620,500            |                      |
| Without Project        | 4,820,000            | 1,021,000            | 2,142,500            | 1,656,500            |                      |
|                        |                      |                      |                      | 964,000              | 500,000              | 1.93                 |

Multi-Period Benefit-Cost Analysis

Most projects involving capital investments stretch out over a number of years. Typically, agricultural investments, e.g., irrigation pumps, marketing facilities, or livestock shelters, yield little or nothing in the early periods in which they are implemented and then produce a stream of benefits that may last well into the future. Figure 6.2 depicts graphically the time stream that these types of projects generate. At first, the cash flow of net benefits (incremental benefits plus investment costs) is negative because investment costs dominate returns. As project costs decline and benefits increase, the weights are reversed and the cash flow becomes positive. This cash flow is discounted and summed to compute the project’s benefit-cost ratio.

Figure 6.2. Benefit and Cost Streams Over Time
**Investment Costs**

Table 6.3 provides a breakdown of investment costs at private prices. The numbers are purely illustrative, but they show the types of items that might be included in an irrigation pump investment model.

<table>
<thead>
<tr>
<th>Table 6.3. Investment at Private Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rp/hr</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Share of pump</td>
</tr>
<tr>
<td>Unskilled labor</td>
</tr>
<tr>
<td>Mechanic</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.4 showing investment costs in social prices is the same as the one at private prices--except for the cost of the pump. Private pump prices are roughly 20% above import parity prices. The effect of this policy is to create incentives for investment in small-scale manufacturing. It is a strategy designed to encourage broad-based rural development, albeit at the expense of development in agriculture. (Estimating the values in the social table follows the procedures used to calculate export and import parity prices outlined in Chapter 4.)

<table>
<thead>
<tr>
<th>Table 6.4. Investment at Social Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rp/hr</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Share of pump</td>
</tr>
<tr>
<td>Unskilled labor</td>
</tr>
<tr>
<td>Mechanic</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

In actual project work, developing a detailed picture of the magnitude and timing of project costs usually receives a good deal of attention. Software such as Microsoft Project is often used to analyze the tasks and costs of complex projects.

**Computing a Discounted Benefit-Cost Ratio**

The multi-period example in Table 6.5 shows the impact of discounting on private benefit-cost ratios. If an investment of Rp 5,000,000 were made in a single-period model and the profits were the same as in the previous example, the B-C ratio would be .24. The project would clearly not be feasible. However, the actual activity envisaged in Table 6.5 improves the field’s water control by leveling the land, strengthening the bunds, and deepening the surrounding drainage ditches. It is assumed that each plot can be farmed three times a year, i.e., there is triple cropping. In the season when the work on the land is undertaken, there would be no production. In the subsequent 19 periods (roughly 7 years), however, increased profits would accrue without...
Table 6.5. Multi-Period Benefit-Cost Analysis (Private Prices)

<table>
<thead>
<tr>
<th></th>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
<th>Investment Costs</th>
<th>Undiscounted Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inputs</td>
<td>Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Project</td>
<td>7,230,000</td>
<td>966,000</td>
<td>2,082,500</td>
<td>4,181,500</td>
<td></td>
</tr>
<tr>
<td>Without Project</td>
<td>6,025,000</td>
<td>966,000</td>
<td>2,082,500</td>
<td>2,976,500</td>
<td></td>
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</tr>
<tr>
<td>30</td>
<td>1,205,000</td>
<td>300,904</td>
</tr>
</tbody>
</table>

Discount rate: 5%  
IRR Guess: 5%  
NPV Benefits: 13,869,344  
NPV Costs: 4,761,905  
B-C Ratio (single period): 0.24  
B-C Ratio (multi period): 2.9

Further investment. Evaluation of these profits and costs, at full development and without discounting, would yield a benefit-cost ratio of approximately 4.6 (Rp 22,896,000/Rp 5,000,000).
Discounting the elements of the project shown in Table 6.5 at an annual discount rate of 15 percent (5 percent per period or season) yields a benefit-cost ratio of 2.9. Costs, because they occur in the first year of the project, are discounted very little. The discount factor in that year is only .9523. Benefits in the 20th period, on the other hand, are discounted more heavily because they occur much further in the future; the discount factor in that period is .3768. The result is a significantly smaller B-C ratio than that computed with undiscounted data.

The benefits of the improving the water control on the plot would probably continue for a decade or more. However, the discounting procedure would render these benefits very small and they would have little effect on the sum of the benefits. For example, at 10 years (30 periods) the discount factor, using a rate of 5 percent per season, would be .2313. Fifteen years with three crops each year would yield a discount factor of .1113. The lesson of the discounting calculations is that most of the benefits of the project must be realized within the first 10 years (30 periods) to have an impact on the benefits of the B-C ratio.

The time series in Table 6.5 shows each element of the discounted cash flow. Algorithms available in spreadsheets bypass the need to compute each element separately and yield the net present value of a time series at a specified interest rate. They implement the following formula:

$$\sum_{t=1}^{n} \frac{\Delta D_i}{(1+i)^t} \sum_{t=1}^{n} \frac{I^P}{(1+i)^t}$$

The numerator of the formula sums the discounted benefits, the denominator the discounted investment costs.

The data in Table 6.6 are drawn from the with and without PAMs calculated at social prices. The discounted social B-C ratio, computed using the NPV formula for benefits and costs is 2.2, well above 1.0. The internal rate of return is 19%, equally well above the 8% seasonal rate. (Periods interest rates represent cropping seasons and are not annual rates.)

<table>
<thead>
<tr>
<th>Table 6.6. B-C Ratio and IRR Calculation at Social Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
</tr>
<tr>
<td>With Project</td>
</tr>
<tr>
<td>Without Project</td>
</tr>
<tr>
<td>Difference</td>
</tr>
</tbody>
</table>

33 Guidance in choosing private and social discount rates is given in Chapter 4, pp. 41-42. A more detailed analysis can be found in PAM, pp. 200-203.

34 In Excel, the formula for computing the net present value of a time series is =NPV(rate, range) where rate = the discount rate, and range = the cells containing the time series.
Several—often offsetting—effects account for the difference in the B-C ratio. For example, the private price of rice is roughly 25% above the import parity price as a result of duties placed on imports. The main source of the lower social B-C is the tariff on rice that causes the private price of rice to be 25 percent higher than its world market price. The subsidies on tradable inputs and capital are relatively minor effects, as explained in Chapter 5.

**Computing an Internal Rate of Return (IRR)**

The formula used for computing the discounted benefit-cost ratio in Table 6.5 requires analysts to supply a discount rate. Sensitivity analysis on the discount factor is then done by providing a new rate and re-computing the formula. A more flexible approach, favored by the World Bank and other international agencies, is based on finding a discount factor that would equate discounted benefits and costs. This rate can then be compared with alternative estimates.
of the private and social costs of capital. If the private and social costs of capital, i.e., the interest rates, are less than the private and social discount rates, the project is feasible.

The formula for the IRR is given below: \(^{35}\)

\[
\sum_{t=1}^{n} \frac{\Delta D_t}{(1 + i)^t} - \sum_{t=1}^{n} \frac{I_t^P}{(1 + i)^t} = 0
\]

The first term in the equation is the sum of discounted benefits. The second is the sum of discounted costs. The internal rate of return is a value of the discount rate \(i\), such that discounted costs and benefits are equal. The first element in the time series in Table 6.5 is negative because benefits are 0. Thereafter, the benefits are the incremental profits resulting from the subtraction of the without PAM from the with PAM that contains an I-O table with improved yields.

The spreadsheet’s algorithm as applied to the time stream of benefits and costs in Table 6.5 (private profits) yields an IRR estimate of 24 percent. The IRR of the cash flow shown in Table 6.6 (social profits) is 19 percent. The social IRR is lower than the private IRR for the same reasons that the social benefit-cost ratio was lower than the private ratio in previous analyses. \(^{36}\)

Both of these IRRs are well above the usual estimates of the private and social costs of capital for Indonesia. However, it is not difficult to see that marginal projects might produce contradictory results, i.e., the private benefit-cost ratio might be greater than one while the social benefit-cost ratio was less than one or vice-versa. Planners would prefer to use the social rate because it reflects the real costs of capital to the economy as a whole. Care must be exercised, however, in undertaking projects based only on social profitability (efficiency). If the incremental private profits are negative, the private incentives needed for implementation of the efficient project will not be adequate. Differences between private and social rates of return on projects make the same case for policy reform that arise from examining the results of the original PAMs on which the calculations are based.

For example, in the case cited previously, the yield from improving water control was substantial, e.g., 1000 kgs/ha. When valued at social prices, the resulting B-C ratio was 2.8. Because rice production was protected, private profits were greater than social profits and yielded a B-C ratio of 2.9. In this example, private and social benefit-cost ratios pointed in the same direction and planners can proceed with the knowledge that private incentives are consistent with social efficiency. But in many situations, farmers are directly or indirectly taxed on their output. The result can be a social B-C ratio that is greater than one while the private B-C ratio is less than one. In this case, farmers will have little interest in expending resources to

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35 In Excel, the formula for computing the internal rate of return is =IRR(range, guess) where range is the range of cells that make up the time series and guess is an interest rate that will help the algorithm begin the iterative procedure it uses to find an answer, i.e., an “\(i\)” that satisfies the equation.

36 These rates can be tested by inserting them as discount rates in the benefit-cost calculation. The result should be a B-C ratio of 1.
undertake their share of the project. Without policy reforms that remove the output taxes, the project is unlikely to be implemented successfully.
Chapter 7: Market Failures and Environmental Externalities

The Policy Analysis Matrix (PAM) approach identifies divergences from market failures and distorting policies as the causes of differences between private (actual market) prices and social (efficiency) prices. The PAM method can be extended to analysis of environmental issues of primary concern to economists who study the allocation of natural resources. The purpose of this chapter is to explain and illustrate how PAM analysis can deal with market failures, especially those caused by environmental externalities. Illustrations of how to analyze these environmental market failures are contained in the accompanying computer tutorial.37

Environmental Market Failures

The environment refers to the use of physical resources, such as soil, water, or air. Most environmental market failures in the agricultural sector occur when producers misuse a physical resource because they do not have to pay the full costs of that resource. There are two types of environmental market failures – environmental externalities and environmental degradation.

Environmental Externalities

Externalities are market failures. In general, negative externalities arise when a producer or consumer imposes costs on others for which the imposer cannot be charged, and positive externalities occur when a producer or consumer creates benefits for others for which the provider cannot receive compensation. Environmental externalities fit into this general pattern of external market failures. They are distinguished by involving the use of physical resources, particularly soil and water in agriculture.

An example of a negative externality is the use of chemical pesticides in irrigated rice production. Pesticides are applied to paddy rice in fields of standing water. The chemical residues remain in the water when it is drained from the paddy field. Others, located downstream, later use that water for drinking, irrigation, livestock production, or producing fish in ponds. Those downstream users of the polluted water suffer if the pesticide residues cause health problems for humans or their animals or decrease the productivity of their farming or fishing. But these recipients of negative external effects have no way of charging the upstream rice farmers for polluting the water. The market fails to include the negative external costs of pesticide residues in the upstream rice farmers’ production costs. Consequently, there is a role for government intervention to correct the negative externality.

Environmental Degradation

The second category of environmental market failures is environmental degradation. Environmental degradation refers to the overuse of physical resources – soil, water, air, and forests – by producers or consumers. This overuse occurs because producers or consumers have

37 Environmental externalities in the Policy Analysis Matrix are analyzed and illustrated in a manual for a computer tutorial prepared by Carl Gotsch and Stefano Pagiola entitled Volume II: Environmental PAMs, Food Research Institute, Stanford University, 1995. That manual draws on unpublished papers by Dennis Cory and Eric Monke, Using the Policy Analysis Matrix to Address Environmental and Natural Resource Issues, APAP II, Food Research Institute, Stanford University, September, 1991, and by Stefano Pagiola, A Cost-Benefit Analysis of Soil Erosion: The Case of Kenya, Food Research Institute, Stanford University, 1991.
little or no incentive to limit their exploitation of the natural resources. Often the negative impact on agricultural production of over-exploiting forest, soil, or water resources or on farm household consumers of over-cutting forests occurs only in the future. Even if these households understand that their actions are degrading the natural resource base on which their livelihoods depend, they often postpone actions to conserve the resources if the degradation is not likely to have an impact for many years. Whereas environmental externalities impose immediate costs on others, environmental degradation imposes future costs on all users of natural resources including the households responsible for degrading the resource base.

Economists who analyze the use of natural resources identify a special measure, which they term “user cost”, to study environmental degradation. User cost, in environmental economics, refers to the discounted present value of foregone earnings from the use of a natural resource (such as soil, water, forests, or a mineral deposit). The idea is to measure the entire stream of benefits from resource use over time, not just those expected in the current year or the near future. If users understand the likely impacts of their immediate use of resources on future opportunities, they can be encouraged through policy actions to invest in activities – such as terracing, drainage, or reforestation – that conserve resources for future use.

An example that illustrates environmental degradation is provided in the second part of the computer manual on environmental PAMs. Farmers growing irrigated rice use tubewells to tap underground water aquifers. With the passage of time, they gradually deplete the aquifers and reduce the capacity of the soils to remove salts. In the future, less water and greater salination of the soils decrease yields of planted crops. If these negative effects will not occur for many years, farmers have little incentive to invest in drainage and to conserve water use. There is a role for government policy to try to correct this market failure. The government then might choose to invest in public irrigation or drainage facilities or it might decide to subsidize rice farmers’ investments in drainage.

Unsustainable Versus Sustainable Production Practices

The presence of environmental market failures creates unsustainable agricultural production systems. A production system is unsustainable if the farming practice imposes negative environmental externalities (such as downstream pollution of water through chemical residues), creates environmental degradation (such as salination of water aquifers), or results in both types of market failures. The costs of agricultural production in unsustainable systems are underrepresented because they ignore the immediate negative external impacts on others (e.g., downstream users of polluted resources) or the long-term degradation of the natural resource base (e.g., salination of the water table).

The absence of environmental market failures creates sustainable agricultural production systems. A production system is sustainable if the farming practice imposes few or no negative environmental externalities and creates limited or no environmental degradation. Production systems also can be sustainable if government policy corrects for negative externalities and resource degradation. The costs of agricultural production in sustainable systems are fully accounted because they include the immediate negative external impacts on others and expenditures to offset the long-term degradation of the natural resource base.
An example of an unsustainable agricultural system is an irrigated rice system in which farmers impose negative externalities by over-using pesticides and engage in resource degradation by refusing to invest in drainage. The opposite example of a sustainable agricultural system is an irrigated rice system whose farmers stop using chemical pesticides or reduce pesticide use to acceptable levels and who invest in adequate drainage facilities to protect the water table for future users. What levels of pesticide use might be acceptable and what amounts of drainage investment might be necessary for water conservation are difficult issues for public policy analysis.

**Public Policy to Offset Environmental Externalities**

The existence of an environmental market failure or of a missing market provides a rationale for government intervention to attempt to correct the divergence. Efficient policies correct market failures to remove or lessen the divergences between private and social prices, whereas distorting policies increase those divergences, as noted in Chapters 4 and 5.

In principle, a government should use tax or subsidy policies to correct environmental externalities. The cost of the negative externality, such as downstream effects of the pollution of water by chemical pesticides, would be included in assessing the costs and benefits of the agricultural system. A tax on pesticide use would be imposed so that private marginal costs include the external costs and equal social marginal benefits (that is, the full cost of producing the last unit of output would just equal the benefit from that production).

In practice, it is very difficult to use tax/subsidy policy to correct environmental externalities. In most instances, it is extremely hard to measure the external costs with any degree of accuracy. An example shows why. The external costs of pesticide use are the health risks and foregone production opportunities of downstream users of the polluted water. It is virtually impossible to measure either of these kinds of costs. Without some reasonable estimate of external costs, the government cannot select an appropriate rate of taxation to apply to pesticide use.

Governments, instead, have turned to a second-best policy – the use of quantitative standards – to limit the use of polluting inputs. If the health and other external costs are deemed very high, governments have banned the use of certain chemicals in agricultural production. One way to resolve the problem of negative downstream effects of pesticides, for example, is to ban their use in irrigated rice farming. But banning input use is unlikely to be efficient unless marginal costs (including external costs) are extremely high and marginal benefits of use of the input in production are very low. Because the marginal costs typically are unknowable, the selection of an appropriate level for a quantitative standard to regulate input use is arbitrary. In this circumstance, the best that analysts can do is to measure the effects of various levels of the input use on production and to offer educated guesses about their likely external impacts.

**Environmental Externalities in the PAM**

The analysis of environmental externalities in the PAM framework can be illustrated in a four-step procedure:
1. The first step is to construct a PAM for an unsustainable agricultural system. The production process imposes a negative externality on others, but the producers ignore the external costs in the system.

2. The second step is to construct a sustainable PAM for the same agricultural system. The government enacts a policy to offset the effects of the negative externality. Either producers pay a tax on the input causing the externality or the government imposes a quantitative standard (a quota or a ban) on use of that input.

3. The third step is to construct an environmental PAM for the agricultural system. The environmental PAM permits measurement of the divergences caused by the policy to offset the negative externality. It contains a comparison of private entries in the unsustainable PAM with social entries in the sustainable PAM.

4. The last step is to calculate the costs of compliance for the agricultural system. The costs of compliance refer to the private and social costs of removing the negative externality and creating a sustainable agricultural system. The private cost of compliance is the reduced profit to producers in the system under study, and the social cost of compliance is the foregone national income in the studied system.

**Constructing an Unsustainable PAM**

The irrigated rice system, illustrated in the computer tutorial, uses a chemical pesticide to control a potentially serious infestation of rice stemborers. But this pesticide leaves residues in water that moves downstream. The polluted water is used by humans for drinking water supplies and by farmers who produce fish in ponds. These downstream costs are not taken into account by the rice farmers. The negative external effects of pesticide use create an unsustainable rice production system.

The construction of an unsustainable PAM follows the same six steps used in putting together any PAM:38

1. The first step is to compile a table of input-output relationships from farm budgets (built synthetically or from field data). These technical coefficients are assumed to apply in both private and social analysis. The table of input-output coefficients for the unsustainable irrigated-rice system includes a series of entries for chemical pesticides and herbicides hectare. These anti-stemborer pesticides and anti-weed herbicides contribute to the system’s achieving a high yield of paddy (unmilled rice) per hectare. But use of these chemicals creates negative downstream externalities to the point where the current rice producing system has been determined to be “unsustainable.”

2. The next step is to assemble a table of private (actual market) output and input prices. The table of private (actual market) prices contains entries for each of the production

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38 These steps are illustrated in more detail in the accompanying PAM computer tutorial.
inputs and outputs listed in the table of input-output coefficients. All entries are in local currency, and the local currency unit is denoted by Rupiah (Rp).

3. The third step is to calculate a private budget (by multiplying the input-output coefficients by the private prices) and a social budget (by multiplying the input-output coefficients by the social prices).

4. The fourth step is to assemble a table of social (efficiency) output and input prices. The table of social (efficiency) prices contains entries for each of the production inputs and outputs listed in the table of input-output coefficients.

5. The fifth step is to calculate a social budget. The social budget for the unsustainable paddy system is found by multiplying the input-output coefficient for each entry by the social price.

6. The final step is to transfer the relevant entries from the private and social budgets into the PAM matrix and to calculate the divergences (the bottom row of the PAM) as the differences between private and social entries. The first two rows of the PAM for the unsustainable irrigated paddy system are taken from the private and social budgets. The bottom row, containing the effects of divergences, is found by using the divergences identity to subtract the entries in the second row from those in the first row, as explained in Chapter 2.

An example of an unsustainable PAM is reported in Table 7.1. It was analyzed in detail in Chapter 5. As noted then, the major divergence occurs because of a tariff on rice that increases private prices 25 percent above social prices. The other divergences affecting the costs of production are the government’s subsidies on chemicals and credit; they are are relatively minor. In the unsustainable PAM, the subsidy on chemicals reduces the private costs of tradable inputs by Rp 55,000 (from the full social cost of Rp 1,021,000). Rural credit costs farmers Rp 402,500 per hectare; its opportunity cost to the economy is Rp 462,500, resulting in an implicit subsidy of Rp 60,000.

<table>
<thead>
<tr>
<th>Table 7.1. Unsustainable PAM</th>
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<tbody>
<tr>
<td>(Rupiahs per hectare)</td>
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<tr>
<td>Revenues</td>
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<tr>
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<tr>
<td>Private</td>
</tr>
<tr>
<td>Social</td>
</tr>
<tr>
<td>Divergences</td>
</tr>
</tbody>
</table>

The total subsidy in the system is Rp 1,625,500, an increase in private profits over social profits of 59 percent. But in the absence of these policy transfers, farmers would have made profits equaling more than half of their revenues. The government might be unaware of the high social profitability of this system. Or this system might be one of the most efficient rice-
producing systems in the country and the government feels it necessary to protect less efficient systems. Perhaps the costs of land, which are included in profits (returns to land and management) in this PAM, would reduce the measured profits significantly. All of these possibilities require investigation to interpret the rationale for policy.

Particularly surprising is the government’s decision to subsidize chemicals. The large subsidy encourages farmers to over-use pesticides and worsens the external effects. A more sensible policy would limit, not encourage, pesticide use in this unsustainable system.

Constructing a Sustainable PAM

In the example of the irrigated rice system, the government chooses to ban use of the anti-stemborer pesticide and farmers switch to traditional systems of herbicide control that use natural biological agents and delays in planting times. The new production system has lower rice yields and different labor costs – higher for pesticide control and lower for harvesting and threshing. The downstream users of water no longer incur external costs, since use of the pesticide is stopped, and thus the rice-farming system is sustainable.

The construction of a sustainable PAM follows the same steps used in compiling an unsustainable PAM. Data on input-output relationships and on private and social prices are used to produce private and social budgets, and the budget results are transferred into the first two rows of the PAM.

Several of the input-output coefficients are different in the sustainable production system (shown in Table 7.1 above). Most important, the use of pesticides is banned and so the input of chemical pesticides per hectare falls to zero. Yields decline by 9 percent, from 6,000 kilograms per hectare to 5,500 kilograms per hectare.

When the government bans pesticide use and removes the negative externality, there are no changes in private and social prices of outputs or inputs. The changes in the private and social budgets thus are caused by the new input-output coefficients in the sustainable system. Because of the yield decline, private revenues per hectare fall from Rp 7,230,000 to Rp 6,627,500 and social revenues per hectare decline from Rp 5,784,000 to Rp 5,302,000. Following the ban on pesticide use, private and social costs of tradable inputs decrease to Rp 771,999 per hectare.

The results for the sustainable PAM are presented in Table 7.2. These outcomes differ

<table>
<thead>
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<th>Table 7.2. Sustainable PAM</th>
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<tbody>
<tr>
<td>(Rupiahs per hectare)</td>
</tr>
<tr>
<td>Revenues</td>
</tr>
<tr>
<td>Tradables</td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>Social</td>
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Table 7.2. Sustainable PAM

<table>
<thead>
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<th>(Rupiahs per hectare)</th>
<th>Revenues</th>
<th>Costs</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tradables</td>
<td>Labor</td>
<td>Capital</td>
</tr>
<tr>
<td>Divergences</td>
<td>1,325,500</td>
<td>-</td>
<td>(60,000)</td>
</tr>
</tbody>
</table>

from those for the unsustainable PAM in two principal ways. The ban on chemicals removes the
divergence on inputs. The government formerly subsidized pesticides by a substantial amount.
The policy change is intended mainly to eliminate the external costs, but it also saves the
treasury from providing funds for subsidies.

The government does not change its policy to protect rice by 25 percent and thus to
transfer resources to producers of rice. The output transfer thus continues (Rp 1,325,500 on
social revenues of Rp 5,302,000 per hectare). But the subsidy is reduced because yields have
declined as a result of the ban on pesticides.

Even without pesticides, however, this farming system remains very profitable. Without
rice protection, the farmers still would earn profits amounting to nearly half of social revenue, as
shown in the social row of the sustainable PAM.

Constructing an Environmental PAM

The environmental PAM incorporates the effects of the government’s decision to ban use
of the pesticide and thus create sustainability for the system. Divergences in the environmental
PAM measure the differences between private returns, costs, and profits under the initial,
unsustainable system (the first row of the unsustainable PAM) and the social returns, costs, and
profits under the policy-induced, sustainable PAM (the second row of the sustainable PAM).

The divergences found in an environmental PAM are greater than those in either the
unsustainable or sustainable PAMs because they reflect the effects of restricting use of (or
banning) the polluting input. These comparisons take into account not only the transfers from
protecting rice and subsidizing pesticides, but also the impact on yields of paddy from using or
not using pesticides. When the government chooses to ban the use of pesticides and make the
system environmentally sustainable, that policy decision means that less rice is produced because
yields decline. The divergences in the environmental PAMs thus show the combined effects of
the policy transfers and yield change.

The results for the environmental PAM from the tutorial example are presented in Table
7.3. When the government permitted – and even subsidized – pesticide use, the irrigated rice
system produced 6 tons of paddy per hectare worth 7,230,000 and 73 percent of that revenue was
returns to land and management (private profit).

Table 7.3. Environmental PAM

<table>
<thead>
<tr>
<th>(Rupiahs per hectare)</th>
<th>Revenue</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
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Table 7.3. Environmental PAM

<table>
<thead>
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<th></th>
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<th>Costs</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tradables</td>
<td>Labor</td>
<td>Capital</td>
<td>Profits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private (unsustainable)</td>
<td>7,230,000</td>
<td>966,000</td>
<td>1,680,000</td>
<td>402,500</td>
<td>4,181,500</td>
<td></td>
</tr>
<tr>
<td>Social (sustainable)</td>
<td>5,302,000</td>
<td>771,000</td>
<td>1,680,000</td>
<td>462,500</td>
<td>2,388,500</td>
<td></td>
</tr>
<tr>
<td>Divergences</td>
<td>1,928,000</td>
<td>195,000</td>
<td>-</td>
<td>(60,000)</td>
<td>1,793,000</td>
<td></td>
</tr>
</tbody>
</table>

The government then decided to ban the use of pesticides and remove the negative externalities afflicting downstream users of water, but it did not choose to stop protecting rice producers. The ban on pesticides and ensuing new production practices caused paddy yields to decline by 9 percent, from 6 to 5.5 tons per hectare. But private and social profits remain high. This extremely efficient system is thus viable even without using pesticides, although both social and private profits are reduced by the pesticide ban.

Calculating the Costs of Compliance

The costs of compliance refer to the private and social costs of removing the negative externality and creating a sustainable agricultural system. They are found by comparing profitabilities in the unsustainable PAM (with use of the pesticide) with those in the sustainable PAM (without any pesticide use). The private cost of compliance is the decrease in private profits – the reduced profit to rice producers – associated with the policy to ban pesticide use. The social cost of compliance is the decline in social profits – the foregone national income – from banning the pesticide. The costs of compliance from the tutorial example are presented in Table 7.4.

Table 7.4. Costs of Compliance

<table>
<thead>
<tr>
<th></th>
<th>Unsustainable</th>
<th>Sustainable</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paddy</td>
<td>Paddy</td>
<td>Costs</td>
</tr>
<tr>
<td>Private</td>
<td>4,181,500</td>
<td>3,774,000</td>
<td>407,500</td>
</tr>
<tr>
<td>Social</td>
<td>2,620,500</td>
<td>2,388,500</td>
<td>232,000</td>
</tr>
</tbody>
</table>

The private cost of compliance refers to the impact of the pesticide ban on the producers of irrigated rice. When farmers could use pesticides, they earned returns to land and management of Rp 4,181,500 per hectare. After the government banned pesticide use, the returns to land and management decline to Rp 3,774,000 per hectare. Farmers thus suffer a loss in private profits of Rp 407,500. Although farmers are sure to be vocally unhappy about this result, their lower level of private profit is a healthy portion of revenues, and the government’s protection policy continues to transfer substantial amounts per hectare from rice consumers to farmers.

The social cost of compliance is the loss of national income incurred because of the decision to eliminate the negative externalities associated with use of pesticides. National
income is measured by social profitability. Yields were 6 tons per hectare when the government permitted use of pesticides. The production system with pesticides generated social profits of Rp 2,620,500 per hectare. Yields decline to 5.5 tons per hectare when pesticides are banned. The less productive system generates social profits of Rp 2,388,500 per hectare. The loss in national income from banning pesticides thus is Rp 232,000 per hectare or 10 percent of the original social profitability.

**Interpreting Environmental PAM Results**

The government needs to determine that the reduction in national income from rice production is justified by the downstream benefits of removing negative externalities. That determination will be difficult because of the complexities of assessing the negative impacts on the health and agricultural productivity of downstream users of polluted water. At best, analysts will only be able to make very rough estimates of those external costs and hence of the benefits of removing them.

Because of the difficulties in assessing the downstream gains from removing negative externalities, analysts typically carry out sensitivity analysis on levels of quantitative standards for polluting inputs. Banning use of a polluting input is likely to be correct only if the external impacts are huge and the productivity enhancement is small. Analysts thus make empirical estimates of the likely effects on yields and social profits of varying levels of polluting input use.

The results from estimating divergences in environmental PAMs and from calculating the private and social costs of compliance assist this kind of analysis. The social costs of compliance show the losses of national income associated with different levels of polluting input use. Disaggregation of the output divergences in environmental PAMs shows how much of the transfers derive from yield declines due to less use of polluting inputs and how much from protection or other subsidizing policies. As in all PAM analyses, the key to interpreting results is to be able to identify and quantify different kinds of divergences – environmental externalities, other market failures, and policy transfers.
Chapter 8: Communicating PAM Results to Policymakers

The policy analysts’ job is only partly done after they have completed their PAM analyses. Results from the PAM then need to be communicated clearly and effectively to policymakers. Otherwise, even excellent analytical work will have no impact on policy decisions. The purpose of this chapter is to suggest guidelines for effective written and verbal communication of PAM results to policymakers and their advisors and staffs.

Importance of Communication

Good policy analysis requires four essential steps. The first eight chapters of this book have focused on the first three of these steps – appropriate choice of research methods to meet policy needs, careful compilation of relevant information, and correct interpretation of results. The fourth critical step is the convincing communication of policy results.

In policy analysis, the written and verbal communication of results is equally as important as the process of analysis to obtain high quality results. If analysts cannot communicate their results well, their work is unlikely to have much influence on policy decisions. Effective policy advisors thus have to be both good analysts and convincing salespeople.

There is a close linkage between effective communication and sensible choice of research design. The more complicated the research methodology, the more difficult is the task of communicating results and convincing policymakers of their relevance. The PAM approach is designed to be both effective in identifying the impacts of policies and projects as well as easy to explain to policy-makers. All policymakers, including non-economists, can readily grasp the importance of profits and policy transfers – the principal results from PAM analysis.

The keys to effective communication of analytic results are clarity and brevity. The use of economic jargon and technical language will not be widely understood by many policymakers and their staffs. Because these people are very busy, they will appreciate concise and accurate communication. Busy, responsible officials are likely to pay especially close attention to policy memos and presentations that are articulate, clear, and short.

Policy analysts should prepare their communications for an audience of non-economists who are likely to be suspicious of economic analysis and wary of yielding power to economists. Economists working on the staffs of policymakers also appreciate receiving communications that focus on policy trade-offs, not on technical sophistication. Prudent policy analysts, therefore, write and speak intelligently using terminology that is likely to be understood by a broad audience of decision-makers.

39 The communication of PAM results is discussed and illustrated in Eric A. Monke and Scott R. Pearson, The Policy Analysis Matrix for Agricultural Development (hereafter PAM), 1989, Chapter 12, pp. 242-246, 252. A prototype policy brief reports the PAM results for a Portuguese wheat system (the one illustrated in detail in Chapter 3) in PAM, pp. 249-252.]
Types of Written Communication in Policy Work

In policy analysis, written communications typically fall into one of three categories – policy papers, policy briefs, and policy summaries. Analysts should write all three kinds of policy communications for each set of results. Policymakers and their staff members use each type of communication differently and unpredictably. When they focus their attention on a piece of policy analysis, they might request a full paper, a detailed memo, a short summary, or sometimes all three types of policy communication. Moreover, they typically demand these communications on very short notice. Policy analysts thus need to be prepared to deliver their results in papers of differing amounts of detail and without delay.

Policy papers are the longest form of written communication of policy results. Although it usually is much easier to write long papers than short ones, effective communication requires brevity. The text of policy papers thus should not normally be longer than 15 to 20 pages. Tables, graphs, and appendices are additional. Often analysts first write a long draft paper that incorporates all of their results. They then trim it back to no more than 20 pages of text and essential results before presenting it to policymakers and their staffs.

Policy briefs are the most common, and usually the most effective, form of written communication of policy results. Few busy policymakers or staffers bother to read a 20-page policy paper carefully. But they are attracted to shorter policy briefs that are well designed and clearly written. A sensible target length for a policy brief is 6-8 pages (double-spaced, normal font size, standard margins). Analysts find it taxing to tell their stories in so short a space. But the payoffs in having influence on policy decisions are high.

Policy summaries, sometimes called executive summaries, are the shortest form of communication of policy results – only 1-2 pages long. These summary statements cover the same ground as policy papers and policy briefs, but they only highlight the key methods, data, results, and policy implications of the study. A policy summary is intended to advertise the research results and to encourage policy-makers and their staffers to read the longer papers. Because they are the shortest, policy summaries are the most difficult to write.

Writing Policy Papers

The purpose of a policy paper is to provide detailed information for staff members of policymakers. Only rarely do policymakers take the time to read a policy paper carefully. The policy paper typically serves as a backup to the central document, the policy brief, to offer clarity on technical and policy questions.

The key rule to follow in writing a policy paper is to make sure that other researchers can replicate all of the results. Argumentation in policymaking occurs at several levels. One of those is the technical level. Other analysts must be able to reproduce the results in a policy paper to be convinced of their accuracy. Otherwise, they will ignore the analytic results and policy recommendations, and the research will be irrelevant for policy purposes.

The need for clarity and brevity governs the writing of policy papers as it does all written and oral communication of policy results. If an analyst is limited to writing a text of no more than 15-20 pages, there is a tendency to want to include results in other ways outside of the text.
To curb this impulse, the number of tables or graphs should be limited to between 6 and 10. Appendices should not be used as dumping grounds for text that was cut from a lengthy first draft. Appendices should contain only essential technical material on background, methods, and data.

**Components of Policy Papers**

Policy papers usually have five sections that occur in the following logical order – the methods of analysis, the key methodological and data assumptions, the principal data and sources of information, the empirical results of the analysis, and the major interpretations of results and their implications for policy. A key to successful writing of policy papers is to thread a story line through the paper that integrates all five of these sections.

The discussion of methodology should focus on what the analytic approach is and why its application is appropriate to study the policy issue at hand. This section ought to be brief and to the point since few policymakers have intrinsic interest in economic methodology.

All methods of economic analysis have limitations and require the use of strong assumptions. In most empirical work, some important kinds of data are missing or are of questionable accuracy. The section on methodological and data assumptions used in the analysis should highlight the limitations as well as the strengths of the analysis.

Data refer to more than just the numbers used in the empirical analysis. Policymakers need context to understand the importance of the new results. The section of data and sources of information thus includes relevant historical information as well as discussions of the quality of information used and of fieldwork procedures.

The computational power of microcomputers permits policy analysts to generate large quantities of empirical results. Policymakers have limited patience when analysts carry out lengthy investigations of the sensitivity of results to changes in key assumptions. Only the results central to policy options need to be reported. Less is better.

To be most helpful to policy-makers, analysts need to interpret their results in ways that are understandable and relevant in decision-making. The implications for policy need to focus on the impacts on the winners and losers from various policy actions. Policy decisions are political. Policymakers have to decide whom to help and harm. They thus will pay especially careful attention to this last section of the policy paper.

**Writing Policy Briefs**

The suggestions here on writing policy briefs are concise because the *PAM* book contains full explanations as well as an example of a policy brief (for a wheat system in Portugal).\(^\text{40}\) Those materials should be used in conjunction with this chapter. Each policy brief should contain seven sections – issues, methods, information, interpretation, results, ramifications, and summary. The structure and components of a policy brief are summarized in Figure 8.1.

\(^{40}\) *PAM*, pp. 249-252
Figure 8.1. Writing Policy Briefs

Issues (less than 1 page)
1. policies addressed
2. aspects covered
3. policy context

Methods (1 page)
1. logic and appropriateness
2. previous use plus strengths/limitations
3. qualifications

Information (2 pages)
1. empirical data and complementary information
2. assumptions
3. historical data

Interpretation (2+ pages)
1. empirical results
2. sensitivity analysis
3. meaning and qualifications

Implications of results (1 page)
1. policy choices
2. winners/losers
3. size of gains/losses
4. tradeoffs among government objectives

International ramifications (<1 page)
1. trade effects
2. factor flows
3. diplomacy and obligations (WTO, IMF)

Summary (<1 page)
1. pros and cons
2. empirical lessons
3. analytical contributions
4. consequences for principal interest groups

Issues and Methods
Policy analysis is about half finished once an analyst has identified clearly what policy question is being addressed. The first section of a policy brief sets out the policy issues to be addressed in less than one page. It covers the policy issues, the specific aspects addressed in the analysis, and the broader policy context. 41

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41 PAM, p. 246
Method is the lifeblood of analysts, but not many policy-makers appreciate detailed discussion of method. This one-page section of the policy brief sets out intuitively the logic and appropriateness of the approach used in the study, justifies the method by discussing its application in other policy analyses, and notes the main strengths and limitations of the approach.\footnote{PAM, pp. 246-247}

**Information and Interpretation**

Most policy-makers enjoy learning about fieldwork, and they are curious about the history of policy. The two-page section on information thus is often the easiest to write. It contains discussions of the historical data that provide the policy context, the empirical data and complementary information used in the study, and the key limiting assumptions made.\footnote{PAM, p. 247}

Inexperienced policy analysts find the interpretation section the hardest to write. What does it all mean? Helpful interpretation of results requires the ability to sift through masses of output and focus on key policy findings. In these two (or slightly more) pages, the analyst reports the main empirical results, the results of sensitivity analysis (from changing key data, parameters, or assumptions), the meaning for policy, and the qualifications because of limitations in the method or poor or missing data.\footnote{PAM, p. 248}

**Results and Ramifications**

Good analysts employ the objectives-strategies-policies-constraints framework (developed in Chapter 1) to organize their thinking and writing. In only one page, they set out the implications of their results in that framework. They review the policy choices, note the winners and losers from various policies, estimate the size of gains or losses for interest groups, identify the impacts on government objectives (efficiency, income distribution, and security), and sketch the likely magnitudes of trade-offs among objectives.\footnote{PAM, p. 248}

Although leaders of sovereign states carry out policies at the national level, policy-makers need to be concerned with the international ramifications of their actions. Developing countries only occasionally are large forces in international commodity or factor markets. But analysts need to summarize in one paragraph the possible trade effects and impacts on world prices as well as implications for factor flows (foreign investment and labor migration). They also should assess whether the policy options are consistent with the country’s obligations to the World Trade Organization, the International Monetary Fund, and other multilateral and donor organizations.\footnote{PAM, p. 249}

**Summary**

The role of the policy analyst is to assess the likely consequences of alternative policy choices, not to make personal value judgments about those choices. Although it can be difficult to maintain objectivity or neutrality, the analyst should leave it to the policymakers to place weights on objectives and make policy decisions (as explained in Chapter 1). In a single
summary paragraph, the analyst distills the essence of the message – the pros and cons of the policy choices, the main empirical lessons from the study, the analytical contributions of the study to the issues, and the likely consequences of the policy options for the principal interest groups. This summary paragraph is likely to be the most difficult – and the most important – piece of written policy communication.

**Writing Policy Summaries**

A policy summary is a radically shortened version of a policy brief. Its topic outline thus is identical to that for a policy brief – issues, methods, information, interpretation, implications of results, international ramifications, and summary – as shown in Figure 8.1.

The purpose of writing a policy summary is to present a quick compilation of the study’s results for very busy policymakers, policy advisors, or staff analysts. The idea is to distill the results into one short document that highlights the relevance and importance of the study for the policy decision.

Brevity and clarity again are the bywords for a policy summary. If possible, the summary should be limited to only one page so that it will attract the widest readership. At most, the summary should not exceed two pages (double-spaced, normal font size, standard margins). It should not contain any tables or graphs, unless one picture is so dramatic that it is sure to catch the attention of policy-makers.

Clarity is essential to attract the right readers. Busy policymakers appreciate clear writing. The policy summary is an advertisement for the policy brief (and possibly also the policy paper). Policy-makers are likely to assume that a well-written policy summary is a good indication of clear communication in the longer policy documents as well.

**Verbal Communication in Policy Work**

Once the preparation of written documents – a policy paper, a policy brief, and a policy summary – is completed, the materials needed for verbal communication follow in a straightforward manner. No additional analysis is required. The main issues are what results to present and how best to highlight them.

**PowerPoint Presentations**

If the necessary equipment is available, PowerPoint presentations can be a very effective means of verbal communication. If not, the analyst relies solely on carefully prepared handouts. The handouts include the key slides from the PowerPoint materials. It is helpful to distribute these handouts whether or not PowerPoint is actually used in the presentation.

The PowerPoint slides should follow directly from the policy brief and focus on the seven topics covered there – issues, methods, information, interpretation, implications of results, international ramifications, and summary (as in Figure 8.1 above). If time is very short, coverage can be restricted to presenting the method, a summary of the principal results, and the key implications for policy of the study.

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47 *PAM*, p. 249
Since the format is identical to that used in the policy brief, the analyst only needs to create PowerPoint slides for each of the seven categories of topics. The main tables and graphs can be transferred into PowerPoint slides. It generally is helpful to prepare handouts of all the PowerPoint materials – the slides with text in outline or multiple slide format and the tables and graphs copied separately.

**Focus and Versatility**

A good policy analyst needs to be able to reach his or her audience effectively. It usually is best to expect that policymakers and their staffs will be most interested in the implications of policy options for interest groups and government agencies. Too much emphasis on method, data, and results can be ineffective in communicating with policymakers. But occasionally the audience becomes engaged in technical issues and turns the conversation in that direction. Hence, it is prudent to prepare extra slides – not to be shown in the standard presentation – that contain technical details.

Successful verbal communication also depends on versatility of the presenter. It is not unusual for a high-ranking policy-maker to set up a short appointment, say 15-20 minutes, with the policy analyst. If the presentation goes very well and engages the interest of the policymaker, that appointment might stretch out or another could be set for later that day. To maintain full flexibility, a well-prepared analyst makes at least three different versions of his/her PowerPoint presentation – one of 15-20 minutes for a very short meeting, a second of about 45 minutes to an hour, and a third for up to two hours. For any length of presentation, it is essential to plan to devote at least half the time to discussion.

**Keys to Successful Presentation of Policy Analysis**

Experience shows that there are seven keys to success in presenting the results of policy analysis. These guidelines apply equally whether the communications are written or verbal. They refer to the attitude, demeanor, and presentational style of the policy analyst.

The seven keys to successful communication of policy results are:

1) Clarity is essential for non-technical policymakers to understand the analytical results.

2) Brevity in presentation saves time and demonstrates a deep understanding of the policy issues.

3) Accuracy in carrying out the study and in interpreting its results convinces other technical analysts.

4) Honesty in identifying crucial assumptions or weak data and in interpreting results provides credibility.

5) Straightforwardness in presentational style and avoidance of jargon aid the clarity of the results.
6) Confidence in one’s ability to identify and analyze policy trade-offs strengthens the presentation.

7) Humility in recognizing the limits of economic analysis heightens the validity of other perspectives and makes listeners more open to yours.

If policy analysts strive to apply these lessons in communication, they are likely to be successful in convincing policymakers and their advisors of the validity and importance of their empirical analysis of policy issues. These guidelines are valid for the communication of PAM results and, more generally, of the results from all policy analysis.
PART TWO: CASE STUDIES

The attached studies have been carried out by members of the Outreach Research Network, a program created under the Food Policy Analysis Services. Authors have completed one or more of the workshops offered under the program and then, based on the outline provided in the PAM manual text, carried out field research and computed the elements of a Policy Analysis Matrix. The results of the research were discussed with colleagues in Indonesia and reviewed by members of the Outreach activity, notably, Scott Pearson.

1. The Impact of Government Policy on Clove Production in Minahasa Regency

Joachim N.K. Dumais
Eyverson Ruaw
Celcius Talumingan

The PAM analysis of cloves is the first of its kind in Indonesia. Its objectives are two-fold: (1) determine the breakeven point from which the impact of the government’s planned clove tax can be evaluated, and (2) determine the efficiency of the clove production system under a variety of farming systems and ecological zones.

Due to an unusually high clove price in 2001 (Rp. 70,000 per kilogram), the government’s proposed Rp. 2,000 per kilo price is only 2.8% of the farmer’s profits. If the government used these revenues to carry out research on clove production, especially fertilizer application, and created an effective extension service, the tax could lead to greater profits in the future. Farmers, of course, fear that the tax revenues will simply disappear into operational expenses. They also fear that the price of cloves will revert to long-term trends that are half the price registered in 2001.

Divergences between private and social prices in clove production are minimal. International clove prices taken from the c.i.f. price at Bitung port, North Sulawesi Province. Inputs such as fertilizer receive no subsidies in Indonesia. The conclusion for all varieties in all ecological zones is that clove production is an efficient use of agricultural resources in Minahasa Regency.

2. The Impact of Tariff Policy and Inter-Island Transport Cost on the Profitability of Soybean Production in Ngada Regency, NTT

Wiendiyati
Umbu Reku Raya
Paulus Un

Ngada Regency is an area in East Nusa Tenggara Province where soybeans are grown during the dry season. Typically, soybeans follow paddy and are produced with a minimum of tillage, e.g., after the rice residue is cleared, seeds are simply dropped into a hole made with a
sharp stick. Red beans, grown during the same season, are a food staple often grown as an alternative to soybeans.

Because the rising demand for soybeans in Indonesia has increased the country’s reliance on imported beans, proposals have been made to stimulate domestic production by introducing a soybean tariff. In this study, a policy analysis matrix (PAM) is computed to analyze the desirability of such an intervention in the Ngada area. The data required to calculate private and social profitability were obtained from a survey of farmers in the area and from secondary sources such as CASER.

The analysis of the PAM show that soybeans are both privately and socially profitable. According to the calculations, farmers have a strong economic incentive to produce soybeans and soybeans have a significant competitive advantage over the alternative, red beans. Soybeans are also profitable socially indicating that Ngada Regency has a comparative advantage in producing soybeans as opposed to red beans. Producing soybeans is an efficient use of the Regency’s agricultural resources.

The positive evidence on profitability indicates that introducing a tariff on soybeans would be undesirable and result in a distortion of incentives in the agricultural sector.

### 3. Traditional Versus Intensive Coconut Production in North Sulawesi

Nordy F. L. Waney  
John Tujuwale

The purpose of the study is to assess the efficiency of coconut farming based on the existing farming systems, monoculture versus intercropping; the existing varieties, tall versus hybrid, the existing technology, traditional versus intensive, and on agro-climatic zones, coastal versus mountainous, of North Sulawesi. The government is considering whether to enact policies that favor coconut farmers by subsidizing chemical fertilizers and credit. The purpose of providing input subsidies is to induce or encourage coconut farmers to implement intensive production technology.

The study concludes that intensification has a significant negative impact on farmer incomes. The recommendation that subsidies be used to stimulate the adoption of more intensive technology cannot be implemented. An alternative solution to make the package profitable is to add value by processing coconut products in other forms (e.g., coconut oil, coconut).

### 4. Profitability and Efficiency of the Broiler Industry in Tasikmalaya

Unang, Ir. MSc.

The key priority of the Indonesian government for the livestock sector is the expansion of the poultry industry, in particular the broiler industry. In 1997, about 816 million broilers were produced on Indonesian farms, 30 times the number in 1981. The production of both broilers
and layers grew over 16% per annum compared to 5.2% for indigenous chickens and 4.4% for ducks. Policy makers see the broiler industry as an important source of animal protein. In comparison with cattle, poultry are efficient converters of feed grains into meat.

The research area is Tasikmalaya, a broiler production area in West Java with a great potential for expansion. This study is focused on both partnerships and autonomous firms, using profitability and efficiency to measure competitiveness.

Policy Analysis Matrices (PAMs) based on primary data were constructed for the different production systems. The scale of production was also taken into account. In the larger systems, farmers produced more than 2000 birds per production cycle.

The study found that broiler production in Indonesia is an efficient industry and can exist without any protection. The partnerships and the larger farmers enjoy more profit relative to the autonomous firms and the smaller ones. Levels of efficiency and profitability are influenced by the prices of feed and chicks as well as broiler output.

To increase the profit and efficiency of broiler farmers in Tasikmalaya, several recommendations follow from the results of the study:

- The government needs to be proactive in reducing inefficiencies in input marketing, especially day-old chicks (DOC).
- To provide DOC at appropriate costs, investments to build local hatcheries managed by the local farmers are important.
- Extension programs are needed, especially to help autonomous farmers reduce mortality.
- The farmers, especially autonomous farmers, should be provided with better access to credit facilities.

5. Analysis of Efficiency and Competition of Soybeans Farming System in Jember

Joni M. M. Aji

Soybean consumption in Indonesia increased from approximately 2.0 million tons in the beginning of the 1990s to 2.4 million tons in 2002. At the same time, production declined from 1.86 million tons in 1992 to 0.87 million tons in 2001, following a more than 50 percent decline in harvested area.

At least part of the decline in production is due to a decrease in the soybean import tariff that was reduced from 20 percent in 1998 to 5 percent in 2001. Farm groups have argued that this tariff should be reinstituted despite the negative effects that it would have on consumers.
The present study, using the Policy Analysis Matrix methodology, demonstrates that, even at the current levels of productivity, soybeans yield a profitable return to land and management at both private and social prices. Farmers who have switched to the new seeds developed by Indonesian researchers have been able to increase productivity (and profits) substantially. This finding suggests that government efforts to reintroduce import tariffs on soybeans would be undesirable and would lead to inefficiencies in the use of domestic resources. Government investments in soybean production that are likely to have a high benefit-cost ratio are extension activities that educate farmers on the proper seed bed preparation and planting procedures for the new varieties, as well as cold storage facilities that hold seeds at the proper temperature before planting. General improvements in credit facilities that make it easier for farmers to innovate would also be desirable.

6. The Efficiency and Competitiveness of Na-Oogst Tobacco and Rice Production in Jember Regency

Rudi Hartadi

Tobacco (Nicotiana tabacum L.) is a plantation commodity that pays high taxes, earns foreign exchange, and employs many workers who earn relatively high incomes. In Indonesia, Voor-Oogst (VO) tobacco is used in producing cigarettes without cigar flavoring and clove cigarettes. Na-Oogst (NO) tobacco is the main material for making big cheroots, cigarillos, and chewing tobacco (Santoso, 1991).

As well as showing a downward trend, Bes-No tobacco prices continue to fluctuate substantially. The world market is quite thin, and a small percentage of over- or under-supply creates large percentage changes in price. The result of this high degree of uncertainty has led to proposals for regulations by the Jember Government that would reduce the tobacco area.

The PAM analysis shows that even at reduced prices, tobacco is privately and socially more profitable than the next best alternative, rice. Hence, even though rice is an important food staple, it would not be good public policy to restrict tobacco acreage. The government would perform a useful function if it assisted growers in organizing cooperatives that could negotiate prices with tobacco exporters. Providing information about the situation in international tobacco markets at the time farmers are deciding what to plant, would also be a useful government function.

7. Competitiveness and Comparative Advantage of Beef Cattle Fattening in Bandung Regency

Tomy Perdana

Each region in West Java is currently working hard to develop its agribusiness potential. This requires that they identify commodities in which their region has a comparative advantage. Bandung Regency has identified fattening beef cattle as a competitive activity for farmers in the area. Consumer demand for beef is rising. Indonesian consumption of beef in 1999 and 2000
was 1.8 kg/capita/year. In 2001, it increased to 2 kg/capita/year. (This is not yet to the level before the crisis which was 2.2 kg/capita/year.) When compared to American beef consumption (44 kg/capita/year) Indonesian consumption is still very small. However, it is very likely that consumption will increase rapidly as the economy improves.

The results of a PAM analysis of beef fattening enterprises show that the beef industry is profitable at private and social prices. Fattening both local and imported animals produces profits that create positive incentives for producers and reflect an efficient use of domestic resources. Economies of scale do not appear to be important in determining enterprise profits. Locally bred animals fed by individual farmers on grass and hay is the most profitable fattening activity.

8. The Profitability of Rice Farming in Polmas District, South Sulawesi, Indonesia

Muslim Salam & Rahmadani

Agriculture has consistently been a central focus of the Indonesian government’s development strategies and priorities. The sector has performed a major role in developing the Indonesian economy since the New Order era. Agriculture has contributed to national economic development by providing employment, food, raw material for industries, and foreign exchange earnings. Even since the economic crisis, this sector has continued to show its important role as a “buffer sector” in the economy.

Indonesia had its greatest production success when it moved from being the world’s greatest rice importer to being self-sufficient. (Heytens, 1991:114-137). Unfortunately, this success did not continue for long. Currently, the Indonesian government is importing rice and considering the use of tariffs to make itself less dependent on foreign markets.

The PAM analysis shows that if tradable inputs and outputs are valued at international prices and domestic resources (land, labor, and capital) are valued at opportunity costs, rice producers would earn substantial profits. When commodities have positive social profits, it means that the country has a comparative advantage in producing that commodity. Additional incentives in the form of tariffs or other types of protection are unnecessary.

Increasing rice output in Polmas District is not dependent on higher output prices. Rather, agricultural representatives need to lobby the national and regional governments for expenditures on research programs that would increase rice yields. At the district level, improvements in extension efforts and expenditures on water control would also help to increase rice production.

9. The Competitiveness of Soybean Production in Blitar, East Java

Candra Fajri Ananda
Azis Arisudi
Eddy Suprapto
Nur Prima Waluyowati
In Indonesia, soybean is an important component of the national food supply. It is not only a source of protein, but also a source of minerals, vitamins and fat. In recent years, the demand for processed products such as tofu, tempe, and soy sauce have increased significantly, especially in urban areas.

Production has not kept up with the demand for soybeans. In 1997, approximately 900,000 tons were imported. Imports increased to 1,177 tons in 2001. As a result, groups interested in increasing soybean output have suggested that the government impose a tariff that would make soybeans more profitable domestically and thereby reduce the country’s dependence on imported beans.

The research undertaken in Blitar District developed farm level budgets for soybean production using both traditional and improved technology. The latter consisted of better seeds and more precise water control. Both monoculture and multi-culture cropping systems were investigated. Primary field data were supplemented with secondary data from the Department of Agriculture, the Central Bureau of Statistics and the Regional Bureau of Planning.

The analysis of the Blitar budgetary data, undertaken using the Policy Analysis Matrix methodology, shows that all methods of soybean production are both privately and socially profitable. This leads to the conclusion that protectionist policies that would raise domestic soybean prices above the import parity prices determined in world markets are unnecessary. However, investments in improved technology and better irrigation systems show profits that are greater than traditional technology. These are likely to be areas in which government investments would yield a significant rate of return and reduce dependence on world markets.

10. The Competitiveness of Red Onion Production in Brebes, Central Java

Joko Sutrisno
Sugihardjo
Boedi R. Kaliman

Indonesian production of red onions increased from 495,183 tons in 1990 and to 977,349 tons in 2000. This increase was due to a growth in acreage as productivity declined from 9.27 ton/hectare in 1997 to 7.72 tons in 2001. Researchers believe that the decline occurred largely because crop rotations did not allow the soil to recuperate sufficiently between onion crops. The decline in productivity raises the question of whether onions continue to have a comparative advantage in the rotations practiced by Brebes farmers. Using the PAM methodology, two technologies are examined in detail. One was the traditional technology in which seeds are grown domestically and modest applications of fertilizer and pesticides are used. The second technology featured imported seeds and a more intensive use of inorganic fertilizers and pesticides.

The results of the farm budget analysis show that both technologies are profitable at private and social prices. Onions, for Brebes farmers, have a comparative advantage over other crops they could grow in the dry season. The imported seed technology, however, gave substantially higher profits than did the traditional technology. This was due primarily to the
difference in yields. Farmers using the traditional technology obtained 8,509 kgs/hectare. Those using the imported seed technology received 13,369 kgs/hectare. Private profits for traditional technology were Rs. 6,623,464 per hectare; profits for improved technology were Rs. 13,315,929 per hectare. The number of farmers using the improved technology is small and it is unclear why more growers have not adopted the improved seeds package.

There are virtually no policy distortions in onion red production. The study showed that the only significant difference between private and social prices occurred as the result of a small import tariff on pesticides.

11. The Impact of Agricultural Policy on Soybean Production in West Nusa Tenggara Province

Bambang Dipokusumo
Anas Zaini
Syarif Husni
Haeluddin

Soybean, as a main secondary crop, has attracted much attention from the government of West Nusa Tenggara. Soybean products have played a very important role as a source of food for people in this province. The main users for this commodity are soybean sauce firms and factories for tahu and tempe (very popular traditional foods). The Board of Central Statistics reported that, in the year 2000, the potential land appropriate for soybean in West Nusa Tenggara was about 248,061 hectares, consisting of wetland and upland. Only half (123,124 hectares) was utilized for planting soybean.

Despite a substantial amount of suitable land, soybean production is well below domestic demand. For the country as a whole, consumption is approximately 2.5 million tons while production is only 1 million tons. In the past, there have been substantial tariffs on soybeans, at one point reaching 25 percent. These tariffs have been phased out in recent years and were eliminated in 2003. Representatives of soybean producers have argued that, in the interest of national food security, tariffs should be restored. This study examines the private incentives for farmers to grow soybeans and the extent to which the West Nusa Tenggara Province has a comparative advantage in soybean production.

The PAM methodology used to analyze soybean profitability shows positive profits at both private and social prices. This means that farmers have an incentive to grow soybeans under the current (no tariff) policy regime. Positive social profits indicate that soybeans also have a comparative advantage in West Nusa farming systems. Under these conditions there is no reason to distort prices in an effort to increase land devoted to soybeans. Government intervention should focus on improved extension services and better research programs that would lead to more productive soybean varieties.

12. The Effect of the Rice Tariff Policy in Minahasa Regency

H. Anapu
As the staple food in Indonesia, rice is important in the lives of both rice producers and consumers. Effective January 2000, the government imposed a rice tariff of Rp 430/kg, about 30 percent, to assist rice producers. The rationale for the protection policy was to increase rice farmers’ income and to improve national food security.

The PAM methodology was used to compute private and social profits to rice production, as well as the impact of government policy. The computations showed that private profits were positive for all three farming systems, thanks largely to the effect of the government’s import duty. Social profits were negative when land was included as a cost because the profits of the next best alternative, peanuts, were greater than rice. Minahasa Regency clearly has a comparative advantage in producing peanuts and the current policy-induced incentives to grow rice are distorting resources away from their most efficient use.

Although the production of peanuts is socially more profitable than rice production, farmers prefer to plant rice because of household security concerns, lower perceived risk, and easier marketing arrangements. Farming interests (and some politicians) want to increase rice prices even more to transfer incomes to rice surplus households. But protection of rice harms poor consumers, worsens poverty, reduces human nutrition, raises labor costs, and wastes scarce resources.

13. Is Cultured Shrimp Production in West Nusa Tenggara Still Profitable?

Anas Zaini
Halimatus Sa’diyah
Bambang D. Kusumo

West Nusa Tenggara (NTB) Province, like Indonesia in general, has unusually favorable conditions for the development of cultured shrimp. NTB’s location near the equator allows year-around production. It also has a long coastline, numerous river deltas, substantial resources of fresh and brackish water, and low-wage labor. These conditions, and the application of intensive technology, have resulted in highly productive shrimp farms.

The question is why shrimp exports have been declining when the Rupiah exchange rate has depreciated sharply and thereby improved profitability per ton produced? Several elements have contributed to the decline in exports. For example, there has been a decline in international prices resulting from increased global supplies and the protectionist policies of importing countries. [The latter include such things as stricter health regulations (Japan and Europe) and the retaliation for alleged Indonesian government subsidies (U.S.).]

Profits have also been reduced, and production decreased, because of the increase in taxes imposed by local authorities. These taxes have grown rapidly and now range from 2.5 percent to 20 percent, depending upon the district. Productivity per hectare has also declined.
because of deteriorating environmental conditions. The most desirable areas are being used very intensively and investments have not been made in facilities that would make cultured shrimp a sustainable enterprise.

Although exports have declined, a PAM analysis of the cultured shrimp industry shows that producing shrimp is still a highly profitable if the proper investments are made. From the Government’s perspective these include (1) the provision of law and order so that the foreign investors needed to provide capital feel secure, (2) research on international market conditions, (3) regulations that would limit the overfishing of seed shrimp, and (4) investigations into international state-of-the-art methods for controlling the pests and diseases associated with intensive shrimp culture.

The PAM analysis also shows that the net transfer for the cultured shrimp industry is negative but relatively small. The divergence stems from taxes on output levied by local authorities (4 percent) that is offset by a small implicit subsidy on capital. The result is that private profits are 5 percent less than social profits.

14. The Competitiveness and Efficiency of Potato Farming in Pangalengan

Elly Rasmikayati
Iis Nurasiyah

According to a World Bank analysis in 1991, the demand for vegetables in Indonesia was projected to increase by 5 percent per year between 1998 and 2010. Potatoes play a very important role in menu diversification, because they can be fried, boiled, or baked. The trend of serving more potato-based foods can be observed from five-star hotels to roadside cafes.

Potato production systems needed to meet the increased demand can be characterized by their source of seed: domestic, certified, and imported. Users of domestic seed save tubers from their preceding crop or purchase them from their neighbors. This seed is less expensive but runs the risk of carrying disease over from one season to the next. Certified seed users get potatoes from a joint program between Japan and the Government of Indonesia. Certified seeds are locally grown tubers that are monitored for several generations and “certified” to be disease-free. Growers using imported seed obtain their potatoes from Germany or the Netherlands.

The PAM-based research shows that all three production systems are highly profitable at both private and social prices. However, plots using certified seed were significantly more profitable than those using domestic or imported seed. As there are significant economies of scale in creating and enforcing a certification program, these results suggest that developing such a project might be a good investment for the West Java Government.

15. The Impact of Liberalization on the Competitiveness and Efficiency of the Cashew Systems in Nusa Tenggara Barat Province, Indonesia

Ketut Budastra
Bambang Dipokusumo
Cashew is an increasingly important export commodity for Indonesia. Indonesia’s foreign exchange earnings from cashew exports increased substantially during the last five years, from US$ 19.1 million in 1997 to US$ 34.8 million in 2002.

As a part of its attempts to promote cashew production, the government has stimulated further extension of small-holders’ cashew farms by creating a cashew development project. Under the project, the government provides technical and financial support to small-holders for land clearing and title, cashew seed, fertilizer, tools, and ‘young plant’ care. The average cost of the cashew development project was 1,705,144 Rupiah (about US $ 170) per hectare in 1998.

The PAM analysis, based on commodity budgets, shows that both the monoculture and inter-planted cashew systems in NTB Province are strongly competitive (relative to comparable commodity systems) and efficient (in resource use) because they generate very high positive private and social profits. The monoculture system earned a private profit of 11,764,556 Rupiah per hectare and social profit of 10,242,158 Rupiah per hectare, whereas the inter-cropping system earned a private profit of 20,194,868 Rupiah per hectare and a social profit of 18,434,768 Rupiah per hectare. These profits were calculated as the present value of total profits earned for 25 years (year 1 to year 25).

Existing policies – a 20 percent tariff on pesticide and insecticide inputs and 2.35 percent local tax on output – had little impact on private profits. Pesticides and insecticides accounted for less than 2 percent of production costs. Because these policies created such minor distortions, simulations to liberalize policy had almost no effect on private profits.

Because both existing cashew systems were very competitive and efficient in resource use, policy makers should consider the expansion of cashew plantations as one of the best options to improve the incomes of smallholders, particularly those living in dry land areas. Cashew trees are well known for their ability to survive in challenging physical environments. Emphasis should be given to expanding the inter-cropping system of cashew production, rather than monoculture system, because inter-cropping cashews with corn leads to higher productivity of cashews and substantially higher private and social profits for cashew farmers.

16. The Competitiveness and Efficiency of Rice-Farming systems in North Bengkulu District, Bengkulu Province

Muhamad Mustopa Romdhon
Indra Cahyadinata

Rice is the staple food in Indonesia. In recent years, Indonesia has been a large net importer of rice. The government would like to reduce rice imports and regain rice self-sufficiency. Currently, the government imposes a rice tariff of about 30 percent (Rp 430/kg) and a rice seed subsidy of Rp 400/kg to encourage rice production.
The objectives of this study are to analyze whether the rice-farming systems in Bengkulu are profitable (socially and privately) and whether they would be privately profitable if protection policy were reduced (as it should be in the future to accord with AFTA commitments). According to the PAM analyses carried out in the study, the rice farming systems in North Bengkulu, in both the wet and dry seasons, were highly competitive. They earned private profits (inclusive of land costs) of Rp 2.7 million per hectare and 3.3 million per hectare, respectively. Those systems were also very efficient. They earned social profits (inclusive of land costs) of Rp 1.8 million per hectare and 2.2 million per hectare, respectively. This competitiveness would be reduced in the future (by 2010) if Indonesia complies with its AFTA commitments and eliminates protection on rice.

Private profits from rice production in North Bengkulu were nearly half again as great as they would have been in the absence of policies and market failures. The positive net transfer was caused almost entirely by the 25 percent rate of protection afforded by the tariff on rice output. If that tariff were removed, the net transfer would turn negative and rice-farming systems in Bengkulu would be taxed somewhat by policies and corruption affecting tradable inputs. But social profits would remain at nearly half of social rice revenue, before land costs. Bengkulu rice farmers thus will be able to compete effectively against imported rice unless the future opportunity costs of land become very high. Since rice is the most profitable crop in the region, there is no reason to anticipate that land costs will rise substantially, eroding the area’s comparative advantage in growing rice.

17. The Impact of Technology Improvement on the Profitability of SoE Keprok Citrus Farming in Timor Tengah

M. Robinson Pellokila
Wiendiyati
Umbu Reku Raya

SoE Keprok citrus from Timor Tengah Selatan (TTS) in West Timor is well known for its excellent taste and has good consumer acceptance in Kupang, Denpasar, and Surabaya. Most of the farmers in TTS cultivate SoE Keprok in traditional ways and optimal production level has not yet been reached. Because of its potential to increase regional income, the local government of TTS identified Keprok as an important commodity that could be further developed with improved technology.

The improved farming practices project (OECF) in Tobu village encompasses 250 ha covering 225 farmer-households. Each farmer cultivates Keprok citrus plants on farms ranging from 0.25 ha to 3.00 ha. In the first year, farmers receive seedlings, fertilizer, and pesticide. Then, in the second and third years, they receive more fertilizer and pesticides. Each farmer group is also provided with a water pipe facility for watering planted area in the dry season.

The main purpose of this study is to examine the impact on the profitability of the OECF technology, which combines improved inputs and better farming practices. The study using the NPV PAM methodology compares the new technology with the traditional technologies used to produce Keprok.
The NPV PAMs show strongly positive private and social profits of farming SoE Keprok citrus in Tobu, Netpala, and Ajaobaki. All three regions enjoy competitive and comparative advantages. Keprok citrus production is extremely profitable and efficient in Tobu because farmers in that region have benefited from the OECF project that has introduced improved inputs (chemical fertilizers and pesticides) and better farming practices (weeding and pruning).

The citrus farmers in Netpala devote substantial labor time to weeding and pruning to improve yields, but they have not adopted the intensive use of chemical inputs. The farmers in Ajaobaki have not introduced either good farming practices or chemical inputs. As a result, their yields and profits are by far the lowest among the three systems.

Technological improvements (with chemical inputs and better farming practices) under the OECF project should be introduced to all citrus-growing areas in TTS. The improved technology is a very efficient use of the region’s resources, and it increases farmers’ incomes substantially.

Divergences in the prices of output (and revenues) have resulted from the 16% import tariff on citrus. The output divergences ranged between 11% and 18%, reflecting differences in local transportation costs in the three study sites.

18. Efficiency and Competitiveness of Rice Production in Riau

Suardi Tarumun

Indonesia produces about 46 million tons of unmilled rice and imports around 2-3 million ton of milled rice each year. Policymakers would like to close this import gap. Many constraints limit increases in rice production. In some areas, rice production is less profitable than perennial commodities, such as palm oil. Moreover, technological change in rice production has been slow in Indonesia since 1990.

One continuing policy proposal has been to reduce the import gap by raising the rice tariff. This would increase the domestic price of rice and create additional incentives for growers to add to the acreage under rice and to increase the level of input use. However, in addition to creating incentives for inefficient resource use, increasing the domestic price of rice would have an adverse welfare effect on non-rice producers who must purchase rice. Most of these consumers live below the poverty line.

This study uses the PAM methodology to examine the efficiency and competitiveness of rice production in Riau. The field work shows that all three rice production systems in Riau were privately profitable (competitive) in 2003. The system in Rokan Hilir also was socially profitable (efficient), but the system in Indragiri was slightly socially unprofitable (inefficient). (Firm conclusions could not be drawn about the efficiency of the system in Rokan Hulu because it was not possible to estimate the social opportunity costs of land in that region.)

The tariff on rice imports provided a positive output transfer in all three farming systems. If the government were to remove the tariff on rice, the taxes on tradable inputs, and the credit
subsidies, the rice farmers in Rokan Hilir and Rokan Hulu would still generate profits, but the system in Indragiri Hilir would lose money. But at the assumed long-run world price for rice of $200 per ton and equilibrium exchange rate of Rp 9000/US$, all three systems would generate healthy private and social profits. In Indragiri Hilir, the weakest system, the long-run social profits would be 14% of social revenue, indicating an ability to compete well without policy transfers.

19. The Impact of Irrigation Development on Rice Production in Lampung Province

Wan Abbas Zakaria
Dyah Aring H.L.
Yaktiworo Indriani

The Indonesian Government seeks to raise rice production by increasing irrigation. Irrigation infrastructure is being expanded in Lampung Province. This study examines the competitiveness (private profitability) of irrigated and rainfed rice production in Lampung.

According to the results of the study, carried out using the PAM methodology, rice production was competitive in both the irrigated and rainfed farming systems during both the wet and dry seasons. Rice production in the irrigated system had much higher competitiveness than that in the rainfed system.

The social returns to management and land (social profitability) of rice production in the irrigated system during both wet and dry seasons were about half of social revenues. The comparable returns in the rainfed system during the wet season were about one-third of social revenues, and those in the rainfed system during the (drought-affected) dry season were negative. But no conclusions can be drawn about efficiency until it is possible to make estimates of the social value of land used to grow rice during a year of normal rainfall.

The development of irrigation infrastructure could increase the productivity and competitiveness of rice farming. But no firm conclusions can be drawn from the results of this study about whether public investment in additional irrigation in Lampung Province is efficient. A complete benefit-cost analysis of irrigation investment in Lampung would require estimates of the social opportunity cost of land used for rice production in normal weather years and information on the investment and maintenance costs of the additional irrigation infrastructure.

20. Pricing of Palm Oil Fresh Fruit Bunches for Smallholders in South Sumatra

Maryadi
Abdul Karim Yusuf
Andy Mulyana
South Sumatra is one of Indonesia’s centers of oil palm production with total planted area of 416,395 ha and production of 1,502,818 tons in 2002. There are 19 processing plants in the province, and the production of oil palm has increased progressively (Department of Estate of South Sumatera, 1999). Most production is of the Nucleus Estate Smallholder (NES) type, also called “PIR”, in which a nucleus plantation owned by a private company collaborates with numerous small farmers, each with about two hectares of oil palms.

The price determination of fresh fruit bunches from palms (FFB) changes every month. The nucleus firms that collect the produce from NES farmers have their own price establishment system, even though the law states that the price should be determined by the FFB Price Setting Team (Tim Penentuan Ketetapan Harga Tandan Buah Segar).48

Theoretically, the buyers’ demand and producers’ supply will determine the market price and the quantity of products to be sold. However, because the market structure of FFBs market is monopsonistic, (there is only one buyer and many sellers), it can be assumed that the behavior of the nuclear firm has a significant impact on the market place and hence on the prices received by small farmers.

The buying price of FFBs by nucleus companies is based on a formula. This price is then adjusted to the balanced real average price of Crude Palm Oil (CPO) and Palm Kernel Oil (PKO) according to the previous export (FOB) and local sales of each company.

This research in this paper uses the PAM methodology to examine the private and social profits of palm oil Based on farm budget analysis, the report produces recommendations for improving the determination of FFB prices and increasing the prosperity of small-scale palm oil producers. The study focuses on how the “K” index is calculated. At present, all components of the “K” index are fully controlled by nucleus estates that do not act transparently. If the index parameters were controlled and regularly audited by a neutral agency, the floor price of the FFBs could be established fairly and beneficially for farmers. The study therefore recommends that:

1. The government should develop compulsory controls, based in law and implemented by an independent institution, to ensure that farmers receive appropriate prices for their FFBs.

2. There should be transparency from the processing firms in providing data on price and cost variables. All cost and price values, determined by the firm, should be audited and serve as public input for decision-making to ensure fair outcomes for the farmers.

3. The FFB conversion ratios from CPO and PKO, which are based on government research done in 1998, should be updated to ensure that they are appropriate

48 The Decree Letter or “Keputusan Menteri Kehutanan dan Perkebunan Nomor 627/Kpts-II/98” on the regulation of buying price determination for FFBs modifies an earlier decree letter (Keputusan Menteri Pertanian Nomor 839/Kps/KB.320/8/97 dated 22 August. However, these regulations, which were expected to guarantee a reasonable price for FFBs produced by farmers and prevent unfair competition, do not work effectively.
PART 3: PAM LESSONS LEARNED FROM THE FPSA RESEARCH PROJECTS

Empirical application of the Policy Analysis Matrix (PAM) approach appears to be straightforward. Sometimes it is. But the experience of the Indonesian faculty researchers, who applied PAM in their FPSA research projects, shows that complications often arise. The purpose of this addendum is to highlight the lessons that the outreach network researchers, as a group, have learned. The hope is that others, who choose to apply PAM in the future, will be able to avoid pitfalls in their research and analysis.

Some of the conceptual problems that the FPSA researchers encountered were particular to individual projects. But a number of key problems arose for nearly every research team. This note identifies eight such problem areas. Within each area, the approach taken here is to state the conceptual problem, identify pitfalls that researchers can easily fall into, and illustrate some of the successful solutions that FPSA researchers found. The eight selected problem areas fall into three categories – organizing PAM analysis, finding private and social valuations in PAM, and interpreting PAM results.

Organization of PAM Analysis

Issues and Systems

How can PAM researchers link the selection of commodity systems with the empirical and policy issues to be addressed? In designing a PAM study, the first step is to decide what empirical questions and policy issues are going to be addressed with the results. It is essential that researchers focus clearly on how they intend to use their PAM results before they begin to design their data collection. In applied research, the issues come first and the gathering of information must follow. It is not enough to be interested intrinsically in the competitiveness and efficiency of farming systems in a particular agro-climatic zone. The funders of the research will want to know the uses that will be made of the empirical results.

The second step in designing a PAM study is to select the representative cropping systems. How many different PAM budgets will be needed to address the issues selected for analysis? PAM researchers select representative systems and stratify the population of farmers according to two or more of a number of different stratification variables:

- commodity – which crop(s) and cropping rotation(s);
- agro-climatic zone – differing by rainfall, soils, elevation, and slope;
- season of production – one wet season and one or two dry seasons;
- agricultural technologies – identified by water control, inter-cropping, high-yielding seeds, modern inputs, and mechanization; and
- areas cropped – owned, rented-in, and rented-out.
In the practical application of PAM, researchers find it difficult to use more than two or three of these stratification variables in choosing their commodity systems. It is easy to see why. The use of an additional variable doubles the number of budgets that will be needed. The choice of only two stratification variables, for example, leads to four commodity systems, whereas three variables would require eight systems and four variables could produce a cumbersome sixteen PAM budgets. Unless research time and budget resources are very ample, PAM researchers have to limit themselves to a choice of only two or three stratification variables that lead to between four and eight PAM budgets. In any event, policy makers and their staffs rarely find it convenient to absorb the results of PAM studies that cover large numbers of commodity systems.

This problem of first identifying the issues to be addressed in the study and then linking those issues with the selection of commodity systems to be studied can be illustrated with reference to two of the studies carried out by researchers in the FPSA outreach network. The first study completed in the program examined the impact of government policy on clove production in Minahasa Regency, North Sulawesi. The objectives of that study were to measure the effects of current and proposed government policies on clove production systems that differed by agro-climatic zone, seed variety planted, and cropping system. These objectives were reflected directly in the selection of clove systems studied. The agro-climatic zones differed by elevations (less than 400 meters and greater than 400 meters). Of the two seed varieties, one (Zanzibar) only did well at lower elevations and the other (Sikotok) only was productive at higher elevations. The two cropping systems were monoculture (cloves only) and multi-cropping (cloves inter-planted with coconuts or maize). The use of what started as three stratification variables was reduced to two – agro-climatic zone/seed (low elevation/Zanzibar versus high elevation/Sikotok) and cropping system (monoculture versus multi-cropping). The study thus reported results from a manageable number of systems (four PAM budgets), and those results directly addressed the study’s policy objectives.

A second illustration of effective linking of issues addressed and systems studied can be drawn from the PAM study of beef cattle fattening in Bandung Regency, West Java. The objectives of that study were to measure the competitiveness and efficiency of beef cattle fattening, using either local or imported feeder cattle, and to analyze the effects of changing the import tariff on feeder cattle. In Table 2 of that study, the author provides an excellent description of the two beef cattle fattening systems, which are stratified by two variables – type of feeder cattle (produced locally or imported) and size of feeding operation (small (less than 10 feeder cattle), medium (11 to 50), and large (greater than 50)). Because the second stratification variable contained three classes, it seemed at first that this research design would require six PAM budgets. But only four PAMs were actually needed, because all of the systems feeding local cattle were small-scale. Hence, the PAM budgets in this study covered systems that were local/small, imported/small, imported/medium, and imported/large. With this choice of representative systems, the study was able to meet its objectives effectively. It examined whether there were economies of size in beef cattle fattening and whether policies differentially affected the different sizes of fattening systems for imported cattle.

Primary and Secondary Information
How can researchers decide how much and what kinds of primary information are needed? The use of good quality information is essential if the PAM budget-based analyses are to be credible and useful. Information is power – in politics and in policy analysis. But gathering primary information is expensive, especially in using the scarce time of researchers. When research budgets are thinly funded, as those in the FPSA project were, it is necessary for researchers to plan the expenditure of their own time and financial resources with utmost care. Some economists are better at advising governments about how they should allocate their public resources for maximum impact than they are in carrying out effective benefit-cost measures in allocating their own scarce research resources.

A key lesson learned from the FPSA-sponsored PAM studies (and from many earlier ones as well) is that researchers should make full use of available secondary information before they expend scarce resources in collecting primary information. Three immediate advantages arise from making complete use of secondary information – before going into the field to gather primary information. One advantage is the huge amount that researchers learn from studying secondary information about their commodity systems. A second benefit is the time saved in the field when field research is designed to fill gaps discovered in available secondary information. A third positive impact from reviewing secondary information is the professional credibility that researchers gain from being able to cite and summarize the results of work done by others. Other analysts, who advise policy makers, tend to be much more helpful if PAM researchers have cited the earlier work that those analysts have done on commodity systems.

A pitfall to be avoided in organizing the collection of information is the assumption that no one else has carried out any relevant previous work on the commodity systems to be studied. A corollary pitfall is the assumption that a researcher should only trust primary information that s/he has gathered in the field. Occasionally, it is true that no useful secondary information exists on a set of commodity systems in a particular region or agro-climatic zone. But that outcome needs to be substantiated through careful empirical effort rather than assumed. Experience shows that at one time or another someone affiliated with Indonesia’s Central Bureau of Statistics or a student writing a Sarjauna or Masters thesis probably has studied the commodity of interest. PAM researchers do well by having a careful look for that kind of information. Network researchers who made careful use of secondary information benefited greatly. In particular, they have been able to see how their own results are similar to or different from those obtained earlier by others and they have successfully put their results into a wider context by comparing them with earlier results and with results from other parts of Indonesia.

Many researchers in Indonesia (and elsewhere) have been taught that the appropriate way to carry out empirical research is to design a good questionnaire, apply it carefully in the field, average the results (after cleaning the data for outliers), and build farm (or commodity system) budgets. Good application of the PAM approach modifies that standard approach. PAM empirical analysis begins with the construction of synthetic budgets. These budgets are synthetic in two senses – they are syntheses of all available secondary budgetary and other commodity information, and they are artificial because they are not based on interviews of farmers, traders, and processors. The purpose of building synthetic budgets is to find out what is already known (or thought to be known) and to identify gaps in knowledge and data. The emphases in primary field data collection, undertaken after the construction of the synthetic budgets, are to verify the
synthetic budgets (built from secondary data), to fill data gaps, and to update and crosscheck all information. When empirical researchers are armed with good synthetic budgets, they can make informed decisions about allocating their field resources to interviews with expert observers (from whom they seek trends and confirmations) versus interviews with farmers, traders, and processors (from whom they seek budgetary data as well as information on local markets). A vital lesson learned from the FPSA-sponsored research has been the value of obtaining high-quality information from expert observers.

These lessons are demonstrated in a study of traditional versus intensive coconut production in North Sulawesi. The objectives of that study were to assess the competitiveness and efficiency of existing systems of coconut production and to see whether the introduction of a proposed new input-intensive system (that would give much higher yields) would be an improvement. The study differentiated existing coconut systems according to agro-climatic zone (coastal versus mountainous), farming system (monoculture versus intercropping), and technology (traditional/tall variety versus intensive/hybrid variety). This complicated study design was made possible by the authors’ previous knowledge of and research on coconut systems in North Sulawesi and by their careful use of secondary data (some of it compiled by one of the authors in earlier work). The compilation of synthetic budgets greatly facilitated the later gathering of primary information. This full research design and careful process of gathering primary information permitted the authors to conclude authoritatively that the proposed intensive systems would not be privately or socially profitable in spite of yield increases of 40-50 percent.

The process of complementing secondary and primary data collection is nicely demonstrated in a study of the efficiency and competitiveness of tobacco and rice production in Jember Regency, East Java. The author first gathered secondary data at the province, regency, and district levels. The data at the East Java Province level were obtained from the Agricultural Department, the Agricultural and Food Commodity Service, and the Plantation Service and Statistical Office. The data at the Jember Regency level were collected from the Bappeda, the agriculture service, the tobacco institutions, and the statistical office in Jember. The data from the district level came from the district office, agricultural, plantation, and farming officials, and extension workers. Then the author turned to the collection of primary information. The primary data came from interviews with farmers, field traders, brokers, and exporters. Further information on the marketing and handling of tobacco and rice was obtained from traders, brokers, and exporters, some of them experts in their specialties. The key lesson was to review secondary information first and then to fill gaps with primary data collection.

Private and Social Valuations in PAM Analysis

 Tradable Outputs and Inputs

How can researchers identify and use comparable world prices for social valuations of tradable outputs and inputs? Finding appropriate world prices proved to be the single most troublesome area for researchers in the FPSA network. Trouble arose mostly from an inappropriate choice of world prices in foreign currency. But there were other problems as well.
To apply the PAM approach, researchers need to make estimates of social valuations for all goods produced and for all costs of production (tradable inputs and domestic factors). The principle is to use comparable border prices (CIF import prices for commodities that are importable and FOB export prices for commodities that are exportable) to estimate the efficiency prices of tradable outputs and inputs. Researchers must ensure comparability of the domestically produced outputs with imports (or exports) across three dimensions – location, form, and time. The approach for import and export parity pricing is intended to ensure consistency across all three of these dimensions. The calculations, in effect, make adjustments to move the commodities from the port to the nearby wholesale market, convert the commodities from processed back to unprocessed form, and store the commodities if the point of time differs. Researchers had no trouble converting world prices from valuations in foreign currencies of processed commodities in the Indonesian ports to valuations in domestic currency (Rupiah) of unprocessed commodities in wholesale markets near the production areas. Everyone applied the approach to import and export parity pricing correctly. Most problems came from the choices of the dollar prices of imports or exports, not from making conversions in them.

Some problems arose when researchers attempted to correct the observed world prices to reflect policy distortions in world commodity markets. World prices are notoriously inefficient in a global sense, because many wealthy countries subsidize and protect their inefficient agricultural producers, causing world prices to be lower than they would be in the absence of those policy interventions. But national efficiency for a single country, such as Indonesia, is measured with respect to the opportunity costs of imports (or the opportunity revenues from exports) that actually exist on world markets, however distorted those prices might be. Border prices show the cost to Indonesia of importing an incremental quantity or the revenue to Indonesia from exporting an incremental quantity. Indonesian policy makers are correct in negotiating hard to have rich countries reform their inefficient policies (especially when they reduce prices for Indonesian exports). But it is not correct for PAM analysts to make upward adjustments in world prices to correct for the estimated effects of policies in other countries – unless it is expected that those policies soon will change. The first lesson in finding appropriate world prices, therefore, is not to adjust the observed world prices because rich countries distort those prices.

The major pitfall (or source of error) in world pricing was the inappropriate choice of qualities. The selected world price must be for a quality that is comparable to that of the commodity produced in Indonesia. The idea in applying PAM is to find the social valuation for an output of a selected commodity system. One error arose, for example, when researchers erroneously tried to match qualities actually imported with the qualities produced locally. Most of the rice produced in Indonesia is of the quality of 25-35 percent broken rice and thus should be compared with the FOB Bangkok price of that same quality rice. Indonesia does import some higher quality rice. Some researchers at first used the price of 5 percent broken rice, reasoning, incorrectly, that this price reflected the price of Indonesian production. Similarly, it is crucial to compare the price of sugar produced in Indonesia with a comparable quality on the world market, not with high quality sugar on the New York market. Correct quality comparisons are crucial.
How can a researcher check to see if s/he might be making a mistake in matching qualities of commodities? The key is to calculate the ratio of the observed domestic price to the selected world price (the Nominal Protection Coefficient on Output (NPCO), for tradable outputs, or the Nominal Protection Coefficient on Inputs (NPCI), for tradable inputs). Then check to see if the calculated NPCO (or NPCI) accords with expectations, given the existence of trade protection or tax/subsidy policies. For rice in 2003, for example, the expectation is that the protection of 25-35 percent broken rice will be in the area of 25-30 percent, reflecting the existence of a specific tariff on rice of Rp 430/kg. An NPCO for rice higher than 1.3 (reflecting the 30 percent tariff) is suspicious and requires either further explanation or a re-look at the numbers used. Also, an NPCO for rice less than about 1.25 is worrisome, unless one can make a convincing argument that the smuggling of rice in the region under study is unusually heavy. Moreover, NPCOs should be nearly the same for one commodity across different systems and between different seasons in a region. If they are not, it is a signal to review the data carefully.

The problem of finding correct world prices is illustrated in a study of the competitiveness and efficiency of rice production systems in North Bengkulu District, Bengkulu. Initially the authors of that study estimated an NPCO for rice of only 1.1 (showing a rate of protection on rice of only 10 percent). Then the authors made two good adjustments to this initial estimate. They first checked to ensure they were using comparable qualities of rice. Then they looked at the conversion factor that they were using to compare wet paddy at the farm-gate with dry rice at the same location. After adjusting for differences in quality and moisture content of rice, they estimated a corrected NPCO of 1.25 (reflecting a rate of rice protection of 25 percent). This result was in line with existing policy if one allows for a small degree of smuggling.

The authors of the study of wetland and dryland soybean systems in West Nusa Tenggara Province also made astute and appropriate adjustments in their early estimates of the NPCOs on soybeans. Initially their NPCOs showed protection in the dry season and disprotection in the wet season, an unlikely result. The authors also made unneeded adjustments to reflect the impact of rich countries’ policies on world prices of soybeans. After careful review of data sources, they changed these early assumptions. The study now shows a tiny output divergence (from errors in the data) that is nearly identical for both wetland and dryland systems. The NPCO for both soybean systems thus is about 1. Getting world prices right will continue to be a challenge in successful PAM analysis.

Labor

How can researchers demonstrate the lack of divergences in the markets for unskilled labor and measure the divergences in the markets for skilled labor? Although social valuations of labor are tricky to estimate, they did not constitute a key problem area for the FPSA-sponsored researchers. Almost all of the on-farm labor was found to be unskilled, and researchers argued that there were not significant divergences in the markets for unskilled rural labor. The observed private wage rates thus were good approximations for comparable social wage rates. The researchers acknowledged some divergences in the skilled labor markets. But most of the skilled labor in the commodity systems was employed in post-farm activities, and those activities typically were analyzed through parity pricing approaches rather than through the
construction of separate post-farm PAMs. As a result, few empirical problems arose in the analysis of labor markets.

The social (efficiency) prices for labor (as well as for capital and land) can be estimated by application of the social opportunity cost principle. Because domestic factors are not tradable internationally and thus do not have world prices, the social opportunity costs of these domestic factors have to be estimated through empirical observations of rural factor markets. The idea is to find how much output and income are foregone because the factor is used to produce the commodity under analysis (e.g., rice) rather than the next best alternative commodity (e.g., soybeans). But in making PAM applications, this principle is applied differently in the markets for labor, capital, and land. The key dimension of the empirical analysis of rural labor markets is to search for divergences (market failures or distorting policies) when carrying out fieldwork.

The PAM researchers classified labor into categories according to gender (female or male), age (child or adult), and skill level (unskilled, semi-skilled, skilled, or managerial). The issue in principle was whether labor productivity differed enough between categories to cause differences in equilibrium wage rates. The observed data on private wage rates showed that virtually all of the labor at the farm level was unskilled, although wage rates differed according to gender and age.

The researchers then searched for the existence or lack of market failures and of policy distortions in the market for unskilled labor. Two types of market failures that might have affected the rural labor markets are monopsonies or oligopsonies (where one or a few large hiring firms collude to depress wage rates) and trade union power (where an organized group of workers legally forces wages upward). Easy entry and exit of laborers in each sub-market was strong evidence of the ineffectiveness of market power exercised by either hiring firms or trade unions.

Two types of distorting policies that might have affected the rural labor markets in Indonesia are minimum wage laws and pension and health insurance taxes (where the government requires employers to contribute to their employees’ pension and health plans and thus raises the cost of hiring labor). These kinds of policies exist in Indonesia, but they are not well enforced in agriculture (except in plantations and processing plants). Policies that do not change labor costs, because they are not widely enforced, are ineffective and thus should be ignored in PAM analysis.

The FPSA researchers found minimal divergences affecting rural labor markets in Indonesia. Distortions were insignificant, because the minimum wage legislation was not enforced in agriculture and had limited impact elsewhere in the Indonesian economy. Fragmentation across labor sub-markets was minor, because of free entry and exit in the labor markets, good information on job opportunities, and widespread use of labor contractors. Therefore, the private wage rates for all categories of unskilled rural labor were considered to be good approximations for the social wage rates. All of the FPSA-sponsored research teams reached this identical conclusion in their field observations.
This conclusion did not apply in the urban labor markets in which much of the post-farm processing and marketing took place. The wage rates for all categories of labor in the urban markets were influenced by two kinds of policy distortions, although not importantly by market failures. Minimum wage legislation was enforced in urban markets. But the distortions were very small since the minimum wage rate was not much different from the comparable market wage rate. In the urban labor markets, social legislation (for pensions and medical insurance) was enforced and caused somewhat higher labor costs. Adjustments thus were made for those distorting policy impacts.

Two studies exemplify the nearly uniform treatment of wage rates and rural labor markets in all of the FPSA-sponsored studies. A study of the competitiveness and efficiency of potato farming in Pangalengan District, West Java contrasted systems that used certified, domestic, and imported seed. The analysis of domestic factor transfers in Table 4.5 of that study showed a complete absence of divergences affecting labor in all three systems. The authors obtained that result by searching for divergences in the rural labor markets. They found no evidence of market failures (there was an absence of oligopsonies and trade union effects) or of distorting policies (neither minimum wage laws nor pension insurance laws were enforced in the market for unskilled rural labor). These observations permitted the authors to make the assumption that the observed private wage rates could be taken as reasonable approximations of social wage rates. Hence, neither the competitiveness nor the efficiency of the three potato production systems was affected by divergences in the labor market.

A study of the competitiveness of soybean production in Blitar District, East Java treated rural unskilled labor in a similar fashion. The authors searched for problems in the rural labor markets but did not find anything significant. They thus concluded that the private wage rates that they observed in their fieldwork could serve as good proxies for the social opportunity costs of rural labor. This empirical finding was both convenient analytically and important in policy terms. The authors found that all four of the soybean systems that they analyzed were competitive and efficient and that the one using an improved technology (with better seeds) was the most profitable. Divergences in the labor market thus did not complicate this key result nor would labor shortages likely be a problem if farmers were to expand the more profitable new technology.

**Capital**

How can researchers find and apply representative private and social interest rates and discount factors in PAM analysis? The valuation of capital was a contentious area. Some researchers employed individual valuations so that differences occur in comparing capital valuation assumptions among the papers. The conceptual and interpretative problems arose mainly in selecting social interest rates and in deciding whether to use nominal or real interest rates in determining capital costs in the PAM budgets and in choosing discount rates in Net Present Value PAM calculations. Some uncertainties also appeared in the application of the Capital Recovery Cost Factor (CRCF).

The costing of capital in private budgets did not pose large problems. The PAM researchers interviewed farmers, traders, and processors to obtain primary data on actual costs of capital borrowed. They divided capital costs into two categories – working capital and
investment capital – and collected data on private interest rates for each category. (Working capital was the finance that a farmer, trader, or processor needed to cover cash costs of production (purchased inputs, hired labor, storage) within a production year. Investment capital referred to expenditures on assets that provide productive services for periods longer than one year.) The sampled farmers obtained their capital from a variety of sources. Listed from least to most expensive (lowest to highest private interest rates), they were farm household savings (from on-farm and off-farm activities), formal credit market institutions (such as commercial and government banks and other financial institutions), kiosk-owners and other traders (who sold fertilizer and related agricultural inputs), and local moneylenders. Traders and processors relied on similar sources of credit. The researchers then calculated weighted averages to find representative nominal private interest rates.

A serious pitfall initially afflicted some researchers when they decided which private interest rate – nominal or real – to apply in costing capital for the PAM budgets or in discounting the private entries in a Net Present Value PAM (NPV PAM) or in Benefit-Cost (B-C) analysis. (The NPV PAM approach is used for perennial crops, such as tree crops, that produce outputs over a number of years.) The lesson learned was that analysts should apply nominal private interest rates in both instances. All other non-capital entries in the PAM budgets reflect the impacts of inflation. It would be inconsistent to remove the effects of inflation from the capital costs only. Similarly, it is best to use nominal interest rates for discounting in both NPV PAM and B-C analyses. Past entries for benefits and costs reflect the effects of inflation. For future projections of benefits and costs, a choice of some inflation rate would be arbitrary (and would serve only to ratchet up the discount rate and thus reduce the future net benefits or costs across all projects). The argument is identical for the choice between nominal and real interest rates in social valuations. Nominal social interest rates are appropriate to value social capital costs in PAM budgets and to use as social discount rates in NPV PAM and B-C analyses.

A few of the researchers had doubts about the application of the Capital Cost Recovery Factor (CRCF) to find the costs of investment capital. This problem occurred mainly in post-farm activities because most farming systems employed little investment capital. The CRCF is an appropriate and convenient technique of allowing both for the interest costs of capital (the return to capital) and for the depreciation of investment capital (the return of capital). The CRCF technique is appropriate because it provides full recovery of capital investment (by using a complete method of depreciation rather than a straight-line approach), and it is convenient because it takes care of interest and depreciation in a single formula. The CRCF is illustrated in the computer tutorial.

Some researchers were tempted to argue that private interest rates could serve as reasonable approximations for social interest rates. But capital market failures were widespread in Indonesia because of the shortage of financial institutions in rural areas. The observed private interest rates thus were a poor approximation of the social interest rates even if the government’s distorting policies, such as rural credit subsidies or interest rate ceilings, were not enforceable in rural areas. Because of the complexity of possible market failures and distorting policies affecting rural credit markets, it was virtually impossible to measure the extent of these divergences. The PAM researchers thus were forced to take a different approach to estimate social interest rates. In principle, the social return to capital can be represented by the rate of
return on the next public or private investment that would be undertaken with additional investment funds. In practice, to estimate the social rates of interest for working capital and for investment capital, the researchers used an arbitrary rule of thumb – the experience of other developing countries when they were at Indonesia’s current level of development. Based on the experience of other countries at comparable stages of development, the social interest rate for capital investment in Indonesia is about 10 percent per annum (plus the rate of inflation) and the social interest rate for working capital in Indonesia is about 15 percent per annum (plus the rate of inflation).

These problems in valuing capital and in discounting can be illustrated with reference to two of the studies done by FPSA-network researchers. A study of the private and social profitability of rice production in Polmas District, South Sulawesi used a private annual nominal interest rate of 12 percent to cost working capital. Most farmers used family savings or retained earnings to finance their working capital needs, and the opportunity cost of those funds was set by the interest rate on savings accounts. That study further used 12 percent as an approximation for the social interest rate for working capital. As argued above, a better estimation of that rate would be about 23 percent (15 percent plus the 8 percent rate of inflation). But because the costs of working capital were less than 1 percent of total costs, this change would have little effect on profits.

A study of the competitiveness and efficiency of cashew production in Nusa Tenggara Barat Province found both private and social annual nominal interest rates to be 20 percent for working capital and 17 percent for investment capital. The private rates are plausible, but the social rates are somewhat low. The argument above leads to nominal social rates of 23 percent for working capital and 18 percent for investment capital. The use of these higher discount rates would reduce the profits of the study’s NPV PAMs for cashew production. An important lesson learned, therefore, is that the choice of appropriate discount rates is critical for NPV PAMs and for B-C analysis.

Land

How can researchers find the social valuation of land and why does that valuation differ from the private land rental rate? Finding reasonable approximations for the social value of land was a vexing problem for nearly all FPSA-sponsored PAM researchers. Initially, several researchers hoped they could assume that the private land rental rates would provide workable approximations for the social land rental rates. But they were all disappointed. After a few false starts, many gave up and eliminated the costs of land from their calculations of both private and social profits. Some researchers stayed the course and went to considerable effort to find good estimations of the social rental rate for land. The lesson learned was that researchers should plan from the beginning to design their research programs and to allocate ample resources to allow for the task of finding the social opportunity cost of land. Otherwise, their PAM results will be incomplete. Approximations of the social opportunity costs of land are needed to produce estimates of efficiency and comparative advantage.

Land is a fixed factor in agricultural production. Some land is located near an urban center and has residential or industrial uses. That peri-urban land is very valuable, but it is not relevant for assessing land costs in agriculture. For agricultural land, the opportunity cost of land
planted to one crop (or cropping rotation) depends on its value in growing the best alternative crop. Farmers allocate their land according to the relative profitability of various crops (along with considerations of household food needs and risk). The value of agricultural land in land sales markets or in land rental markets depends on its productivity and hence its profitability for farmers who buy or rent in the land.

The observed private land rental rates in Indonesian agriculture differed according to land quality and location (usually reflecting the private profitability of farming). The land sales markets were inactive in most of the FPSA research sites. But the land rental markets were extremely active. In most areas, it was the rule rather than the exception for farmers either to rent out or rent in some of their cultivable land. Some farmers rented out land in one cropping season and rented in land in another season. It thus was possible for researchers to obtain accurate estimations of the private opportunity cost of land by gathering information on land rental rates by season of production. The valuation of land in private terms rarely created problems for PAM researchers.

The social valuation of land is carried out through application of the social opportunity cost principle. From the point of view of the national economy, the social land rental rate is found by estimating the social profit of the land in its best alternative use when all costs of land are excluded. For example, the social cost of using a plot of land to grow rice in one season is found by estimating the foregone social profit from not planting that land to the next most profitable crop (e.g., sugarcane). However, this approach requires the researcher to identify the best alternative crop and to carry out a full PAM analysis on it.

In spite of early warnings, many research teams did not budget sufficient time and financial resources in their fieldwork for this task of land valuation. Those that did so had to exert much effort (through interviews with experts and farmers) to find the best alternative crop. But many teams had to give up the goal of finding a reasonable approximation for the social opportunity cost of land. Perhaps the most common answer to the question of what FPSA-sponsored researchers would want to do better in their next PAM research project was that they would carry out a full study of the social opportunity cost of land. In this way, they vowed that next time they would be able to produce convincing and complete analyses of social profitability, efficiency, and comparative advantage. It is not possible to find social profits without knowing the social cost of land.

When it was not practical to study the best alternative crop that might substitute for the crop of primary interest, the researchers had to resort to a second-best approach. Profitability in PAM analysis normally refers to the returns to management (the excess profits after accounting for the costs of all tradable inputs and factors of production, including labor, capital, and land). Researchers, who did not have credible estimates of the social opportunity cost of land, redefined profitability to include returns to management and land (rather than returns to management only). Land costs thus were omitted from both private and social calculations. Because of the difficulty and expense of studying alternative crops to estimate social land rental rates, many analysts adopted this modified approach. But the costs of this shortcut were high, because the modified PAM results could not give full estimates of efficiency and comparative advantage.
The arduous process of finding the social valuation of land is nicely illustrated in two studies by network teams. One study examined the impact of tariff and transport polices on the profitability of soybean production in Ngada Regency, East Nusa Tenggara. The research team searched for the most profitable crop that would substitute for soybean production in the same season. They discovered that many farmers chose to plant red beans instead of soybeans. The team thus used the social profit in red bean production as an estimate of the social opportunity cost of land used in soybean production. They gave equal treatment to soybeans and red beans throughout their paper. What began as an investigation of soybeans thus became a parallel study of both soybeans and red beans. The researchers found a large divergence between their low, observed private land rental rate and their higher, estimated social opportunity cost of land. This divergence resulted from the absence of a well-developed land rental market.

A study of the effects of tariff policy on rice production in Minahasa Regency, North Sulawesi also analyzed the social opportunity cost of land. The most profitable alternative to planting rice was growing peanuts. Peanuts were more profitable—privately and socially—than rice, but many farmers preferred to grow rice for reasons of household food security and the higher production and marketing risks associated with peanuts. The PAM results could not incorporate food security and risk considerations. In their absence, the social profitability of all of the rice production systems was negative, because the production of peanuts was more efficient than rice production. This result indicates the critical importance of estimating the social opportunity costs of land. This lesson is one of the most important learned by the FPSA-network researchers.

**Interpretation of Results from PAM Analysis**

**Private and Social Profits**

How can researchers convince policy-makers of the importance of and differences between private and social profits? Clear communication of PAM results is a central dimension of successful policy analysis. Proper interpretation of results is key for good communication. Two categories of results from PAM analysis—profits and divergences—require interpretation. Within the category of profits, policy makers need to understand what lessons they can draw from measures of private and social profits. One key lesson learned from the experiences of the FPSA-network researchers is the need to interpret all PAM results fully and clearly. Often researchers had to be prodded to spell out the full implications of the results that they had produced. Surprisingly, this result occurred nearly as widely in interpreting private and social profits as it did in explaining divergences (discussed in the following section).

Private profitability is the most straightforward result from PAM analysis. If revenues exceed costs, when both are measured in actual market prices, private profits are positive. Profits in PAM are excess profits (the returns to management), the residual after all costs of production have been accounted for (including a normal return to capital). When a commodity system earns positive private profits, the system is able to compete at current market prices (which include the effects of all policies and market failures). Competitiveness is a result of interest to agricultural producers (farmers, traders, and processors) and to policy makers concerned with agriculture (mostly within the Ministry of Agriculture in Indonesia). But competitiveness (positive private profitability) also is a concern of policy makers concerned with promoting investments to accelerate economic growth, because new investments must increase
(or at least not reduce) private profitability if agricultural producers are to expand their production activities. The PAM researchers understood these concepts, but sometimes they failed to draw out the full implications of their private profitability results.

Social profitability is a more subtle result of PAM analysis. If policy makers are to understand the meaning of social profits, they must first grasp the elusive concept of efficiency prices. When revenues exceed costs, and both are measured in efficiency (or social) prices, social profits are positive. But what is meant by efficiency prices? As summarized in earlier sections, efficiency prices reflect social opportunity costs. An output is valued in efficiency prices by finding what amount the country would earn from producing an additional unit (of an exportable commodity) or would save by not having to pay for an additional unit (of an importable commodity). All inputs (provided by tradable commodities or domestic factors of production) are valued in efficiency prices by estimating what level of income the country gives up by using the goods or services to produce the commodity under study. Efficiency thus is a measure of how the country might best allocate its scarce resources to provide the most output and incomes. When a commodity system earns positive social profits, the system is able to compete at international prices (without any assistance from government policy).

Social profits, which reflect efficiency, are of interest mainly to government officials concerned with promoting rapid economic growth, usually housed in Indonesia in the Ministry of Finance, BAPPENAS, and EKUIN. New investments have to be socially profitable if they are to maximize growth opportunities. Benefits from new technologies or public investments can be found by comparing the social profits from existing commodity systems with expected social profits after adoption of the new technology or implementation of the public investment. Researchers in the FPSA outreach network were familiar with these efficiency concepts. But in writing their papers, they sometimes failed to spell out clearly the implications of their results for non-economist policymakers. In particular, they failed to search deeply enough for good explanations of why commodity systems that had strong private and social profits were not expanding rapidly in their region of analysis. Policy makers need to appreciate the constraints limiting expansion of efficient systems if they are to make public investments, provide more technical assistance, or change price policies to promote agricultural growth. This failure to identify and explain constraints to expansion of profitable agricultural systems is a central lesson learned from the set of research papers.

One good example of interpreting profitability results is contained in a study of the efficiency and competitiveness of soybean production systems in Jember District, East Java. That study contrasted the private and social profitabilities of producing soybeans with a common seed variety and with a new variety (recently developed and disseminated by the University of Jember). The author explained how a relatively small increase in yields (from planting the new variety) led to a one-third increase in both private and social profits, because the production costs for the new variety were only slightly greater than those for the common variety. In drawing policy implications from these results, the author identified seed production and distribution as a key constraint and recommended government assistance to alleviate this problem. He also noted the greater perceived risks associated with planting the new variety, since farmers could not know the threat of disease or pest attacks from a new variety with a short history of field trials and plantings in farmers’ fields. Nevertheless, the author resisted the temptation to call for
government subsidies to promote production of the new variety, noting the very high private profitability of soybean production using both the common and the new varieties.

A second team that interpreted its profitability results well studied cultured shrimp production in West Nusa Tenggara Province. That study contrasted intensive with traditional shrimp farming and showed that both systems were privately and socially profitable. However, the intensive system used good management, forty times as many shrimp seedlings, and much more fertilizer and other purchased inputs to earn huge profits—half of revenues in both private and social prices. The question then became why that system was not expanding rapidly. The authors noted several constraints—foreign (and some domestic) investors worried about the security situation in Indonesia, the absence of judicial predictability, and uncertainties in international markets for shrimp (reflecting recent US protectionist actions). These two good examples of attention to constraints provide instances of a critical lesson learned in policy analysis.

**Divergences**

How can researchers identify and interpret the effects of distorting policies and market failures in the markets for tradable outputs and inputs? The explanation and interpretation of divergences was a problem for all network researchers. The search for and identification of distorting policies and market failures has always been a difficult task in PAM analysis. Still, many FPSA-sponsored researchers showed an unfortunate tendency to want to ascribe their measured divergences to alleged market failures that they never fully justified. The lesson learned from this experience is that the explanation of any divergence—distorting policy or market failure—has to be substantiated convincingly. Otherwise, skeptical readers will likely assume that the researcher has experienced data problems (or, much worse, did not understand the method of analysis). Such an outcome would be extremely disappointing, because PAM is intended to be a tool for policy analysis and the effects of policy are hidden within divergences.

The interpretation of PAM results generally follows a set pattern. The analyst first explains private profitability (moving across the top row of the PAM) and then discusses social profitability (moving across the second row of the PAM). S/he next turns to the causes of the difference between private and social profits. This task requires the identification of divergences (moving separately down each revenue and cost column of the PAM). The logic is straightforward. Private valuations (of outputs and inputs) differ from social valuations because something gets in the way to make the observed market valuation (the private price) diverge from the efficient valuation or social opportunity cost (the social price). What might go wrong? The government might have decided to raise or lower the market price by introducing tax or subsidy policies, trade restrictions, or other policy interventions—collectively called distorting policies. Or the markets might be imperfect and fail to provide efficient valuations because of market failures (monopolies, externalities, or underdeveloped factor markets). Hence, if the observed market price differs from the desired efficient level, the divergence must be caused either by a distorting policy or by a market failure.

This logical sequence was the one typically followed by most network researchers in interpreting their PAM results. But serious problems arose in many of the early drafts of their papers. Many researchers presented numerical divergences, because their private and social
valuations differed. They then looked for distorting policies that might help explain a divergence and failed to find any. Knowing that something had to cause the divergence, the researchers ascribed it to an alleged market failure. Sometimes, they did not even bother to try to identify the cause of the supposed market failure. More often, they cited a study that claimed that a few firms had created an effective cartel and were raising prices of inputs or lowering prices paid to farmers. The lesson to be learned from this experience is that any alleged market failure has to be fully explained – as completely as any alleged policy distortion. There is no question but that traders or processors might want to form cartels to manipulate prices in their favor. But the burden of proof is on the researcher to show how cartels are able to earn excess profits effectively by excluding competition. How might this proof be shown?

The alleged cartels exist off-farm. Cartels try to create imperfect competition by raising prices of goods they sell or reducing prices of goods they buy. To attempt to prove the existence of imperfect competition, the researcher needs first to describe the structure of the marketing system. The number of trading participants gives some insights into the possibility of collusion. However, if a farmer faces a choice of marketers, it will be difficult for a cartel to manipulate prices. The key for researchers is to study the ease of entry and exit in marketing. Cartels must have a way of preventing non-members from entering the market and bidding away their excess profits. Other traders will be attracted by the excess profits and will attempt to enter unless the cartel has an effective way to prevent entry (such as an enforceable government regulation requiring trading licenses). A complementary means of substantiating imperfect competition is to try to measure excess marketing profits. This difficult exercise requires a comparison of marketing margins with marketing costs. Because some cost items are elusive, there will always be a margin of error in these calculations. High profits are a symptom of imperfect competition. Control of entry into marketing is a necessary condition for success of a cartel.

The information and effort needed to substantiate the existence of a marketing cartel is daunting for PAM researchers on limited budgets. The experience of other researchers, in Indonesia and in other developing countries, provides some guidelines in the search for market failures. In the agricultural sector, market failures are very rare in the markets for tradable outputs and inputs. Endless efforts are made to manipulate prices, but few successes are realized because of the ease of entry into marketing crops or inputs. (Market failures are widespread in the rural factor markets (especially for capital and land) in developing countries. Ways of dealing with those market failures have been discussed in previous sections.) Therefore, unless a researcher is convinced that s/he has identified a workable cartel (one that is causing a market failure) and can prove the existence and workability of that cartel, it is best to conclude that market failures in the commodity markets either do not exist or cannot be identified. Divergences then must be ascribed to distorting policies. If that cannot be done convincingly, the research team needs to go back and review its assumptions and data on commodity markets.

The experience of network researchers has shown that almost all alleged market failures have disappeared upon more careful analysis. In a study of the competitiveness of red onion production in Brebes District, Central Java, the researchers initially stated that a cartel raised the private prices of red onions well above social levels. After careful review, they concluded that the small measured difference between private and social prices was the result of errors in their data.
The author of a study of the broiler industry in Tasikmalaya District, West Java argued that a few large firms colluded to raise the prices of day-old chicks (DOC) to smaller poultry firms, creating a market failure for that key nontradable input. But the author also suggested that the high cost of DOC might be caused by unusually strong demand for DOC in a rapidly expanding industry. This study illustrates a key lesson learned – that alleged market failures have to be substantiated convincingly.