FINANCIAL POLICIES AND MANAGEMENT IN THE GROWTH OF AGRICULTURAL DEVELOPMENT BANKS

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Dedicated to:

My Parents, Jorge y Esther
My Wife, Idalia
My Children, Fabiola, Jorge y Esther

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ABSTRACT

Many Agricultural Development Banks (ADBs) face a problem of insufficient financial intermediation capacity. This emerges from their institutional design, specialization in lending at low interest rates, reliance on low cost funds from International Financial Agencies and government subsidies, large operating costs and low loan recovery. Risks and low productivity of agriculture worsen the problem of loan recovery.

A multiperiod programming model was applied to the ADB of Panama to evaluate alternative policies and changes in strategy. The model was for a 10-year planning horizon and it was structured by 298 equations and 513 columns. It included disaggregation in the assets and liabilities, particularly in the loan portfolio; resource constraints and leverage requirements; intertemporal linkages through the maturity structure of assets and liabilities and a measure of risk in the loan portfolio.

The following were the main conclusions: Risk aversion in management of the bank funds could provide higher loan recovery and a more stable growth. Credit insurance provides important direct benefits through higher loan recovery and reduced administration costs. Servicing small farmers, although more costly (on a per dollar loaned basis), does not affect significantly the bank's growth, because small loans have larger average recovery, and shorter maturity than large loans. High cost of borrowed funds and elimination of government subsidies

would lead to failure of ADBs, unless they raise interest rates on loans, improve loan recovery and perform multiple functions. Diversification in the sources of funds, with appropriate interest rate spreads, may be the best way for ADBs to grow and keep up with the financial environment of the years ahead.

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CHAPTER I

INTRODUCTION

Statement of Problem

Credit for agriculture in developing countries is provided by commercial and development banks and by rural financial intermediaries, each serving a particular clientele. Commercial banks serve the largest farmers and operate under rigid commercial practices, characterized by, among other things, strong clientele selection criteria and market rates of interest. Development banks serve the small and medium commercial farmers and follow development oriented policies. Rural financial intermediaries serve the most isolated farmers and those that do not qualify as viable according to the criteria of formal lenders. The concern of this work is with development finance institutions and particularly with the Agricultural Development Banks (ADBs).

Because ADBs are an instrument of government policy for agricultural development, they have peculiar characteristics in their institutional design and they operate under low interest rate policies. The concern of this study is the nature of this institutional design and policies as they affect the banks' financial performance in the following way:

a. ADBs are limited to the issuance of agricultural loans while, on the liability side, they rely mostly on contributions

from the governments and foreign loans under soft conditions. As a result they have a limited capacity to act as financial intermediaries.

b. ADBs operate under interest rates on issued loans that are below market rates. This limits their earnings and hence the rate of growth of loanable funds. These policies have been advocated for development purposes, but also they have been questioned because of the distortions they introduce in the capital markets.

c. As a general rule ADBs are characterized by low loan repayment. This low loan repayment has some of its origins in the instability of farmers' income because of agricultural risks. But it is also due, to a great extent, to moral risks, and due to the inability of the bank to enforce its loan collection procedures.

d. ADBs issue a very large number of loans on a crop and site basis and therefore face high operating costs.

e. Because of their institutional design, high costs and limited earnings on loans, ADBs have very slim resources. This low availability of resources and the large number of farmers that ADBs must serve, means that credit cannot be closely supervised. This contributes to the low loan recovery.

The above defines the generalized operating conditions of specialized ADBs. These conditions are to a great extent

responsible for the limited growth of ADBs at the expense of their own resources, and hence the need for continuous government support.

If agricultural development is to be accelerated, one can expect this to be at the expense of a larger inflow of capital. If such are the needs, ADBs are expected to play a more meaningful role in the supply of financial resources for agriculture. The alternatives to international soft loans and domestic subsidies are no longer viable because of the countries' severe indebtedness. A change in strategy is needed for ADBs to generate their own funds and to improve their efficiency and therefore, grow at a faster rate.

The specific problem with which this study was concerned was the evaluation of alternative financial policies and managerial decisions that would accelerate the ADBs' supply of credit. The interest is in how the growth of credit supply on the aggregate and for specific purposes, can be affected by: i) the bank attitudes towards risk and the enforcement of credit insurance, ii) the elimination of the requirement of serving small farmers, iii) the higher cost of funds and the elimination of government subsidies, iv) increased interest rates on loans and v) the alternative of diversified banking.

Research Objectives

Given the situation described above, the objectives of this research were:

a. First, to develop an analytical framework that explains the performance of agricultural development banks in light of development purposes, institutional design and operating practices. This performance was also explained in relation to the risk in agricultural production and other facts that determine low loan repayment and hence contribute to reduced bank earnings.

b. The second objective was an analysis of changes in the prevailing conditions and how they affect the banks' growth. Various hypotheses are presented and tested for the case of a specialized ADB in Panama.

Summary of Methodology

The achievement of the proposed objectives demanded two stages in the research and hence two methods of analysis:

a. In order to build an analytical framework for the operation of ADBs it was necessary to study their financial structure, their resource endowments, and the policies under which they operate, along with the nature of risks in agricultural production and other factors that affect farmers' loan repayment. To build this framework it was useful to examine the asset and liability structure of ADBs in Latin America, and to review previous studies.

b. The analysis of changes in current operating conditions and financial policies was achieved with the help of a multi-period mathematical programming portfolio model for the ADB of Panama. Previous to designing and building the model, a considerable effort was devoted to a review of earlier models of bank portfolios. Since these earlier models were for commercial banks, the proposed model was enriched considerably through the incorporation of institutional and political constraints and measures of risk in the loan portfolio.

The Choice of Policies

Developing nations are gradually recognizing the need to revise their interest rate policies to agriculture in order to provide credit at market rates. However, changing the interest rate policies by itself is not likely to solve the problem of the limited growth of credit supply by ADBs. As part of a global strategy, this research has analyzed a set of financial policies, changes in institutional design and the availability of credit insurance, all of which would have an impact on increasing the availability of financial resources for agriculture.

The model was used to simulate feasible changes in the context on the Panamanian economic and agricultural sectors and the organization of the Agricultural Development Bank of Panama (ADBP) and the Agricultural Insurance Institute (ISA). These changes include:

i) Increased risk aversion in the management of the bank, and the requirement of credit insurance, reflecting a more careful administration of the funds. As a public institution, the bank could well be interpreted as risk neutral, in the sense that any financial disaster could be overcome with government subsidies or additional soft funds. The insurance program administered by ISA currently covers 30 percent of the bank's portfolio; however, if not supported by the government, ISA will not grow at a faster rate or it may even disappear.

ii) Decreased pressure on the bank to serve small farmers. The issuance of small loans on an individual basis increases the costs of administering bank credit. The policy of not providing credit to small farmers is analyzed in terms of the net effect on bank growth and stability of bank earnings.

iii) Higher cost of borrowed funds. A large proportion of the bank's borrowings come from commercial banks, but with a government subsidy. An analysis is made of higher cost of borrowed funds increasing the interest rate with and without government subsidies.

iv) Diversified banking was evaluated. This situation is feasible in Panama in the short run. It was analyzed by allowing the issuance of bonds of different maturity and savings and checking accounts of different sizes. The analysis also provided information on interest rate sensitivity of borrowing, lending and purchase of securities.

CHAPTER II

AGRICULTURAL DEVELOPMENT BANKING AND THE SUPPLY OF CREDIT: A CONCEPTUAL FRAMEWORK

Introduction

The debate on the financing of agriculture in developing countries has long centered around two basic issues. One issue involves the organization and quality of service provided by the development finance institutions. The other issue involves the financial policies themselves.

Institutional design has made most agricultural development banks (ADBs) a class of rather specialized farm credit agencies. As such, they provide loans for agricultural production and few other financial services. Also, they rely mostly on international soft loans and government contributions, all of which contributes to their limited capacity to act as financial intermediaries.

Financial policies toward agriculture depart from the basic philosophy that low interest rates are a necessary condition for technical substitution and increased income in rural areas. There is, however, much controversy on the validity of these policies. They are in part responsible for a series of distortions in the capital markets, and the inability of the development banks to grow by generating their own resources.

ADBs have reduced earnings, because of interest rate policies and limited financial intermediation capacity. This is one of the major reasons for ADBs to provide a low quality service. But, also in order to fulfill development goals, ADBs must serve a large number of small farmers. This implies high operating costs for the banks.

If agricultural development is to be accelerated, one can anticipate an increased demand for capital. If such is the case, it is necessary to reappraise the financial policies toward agriculture and the role that agricultural development finance institutions must play. This appraisal is already under way [World Bank/EDI, 1981], and new strategies are being suggested.

Considering that the instability of farmers income due to crop failures is an important reason for low loan repayment, credit insurance is being considered among the components of a new strategy to increase the supply of credit. How effective this policy can be, has been up to now a theoretical issue, but some evidence exists that credit insurance increases loan recovery rates. Nevertheless, even when this is the case, the question still remains as to how credit insurance changes the bank's growth of credit supply in comparison with alternative changes in policies and management.

The remaining sections of this chapter analyze the points outlined above, i.e., the institutional design of ADBs and their financial policies; the risks in agriculture and their effect

on income stability and loan repayment; the management of the loan portfolio, the problem of loan recovery, and the effects of credit insurance on the later. Ultimately, this chapter discusses basic concepts in the management of an ADB, and the determinants of the supply of credit.

Agricultural Development Banking: An Overview

Development Purposes and Political Constraints

Development banks are the financial institutions which integrate part of the system necessary to support economic development. As such they have particular ways of fulfilling their functions and also, if publicly owned, they are highly exposed to government intervention.

Development banking emerged in the post-World War II period to meet a need to supply low price capital for economic growth. These banks are intended to provide a complete package of services, including capital and management for development purposes [Basu, 1974]. Most development banks were created with the purpose of serving a particular sector (industry or agriculture), and hence specific types of development projects. The latter are supposed to have high social rates or return, but they also need low cost capital to be financially viable.

Given this characteristic of development projects, banks face a conflict of purposes. Kane [1975] explains that the conflict emerges because, as a development institution, the

bank should deal with those projects with the highest ranking on the development impact scale. As a banking institution, it should finance those projects with the highest ranking in the financial (interest rate) scale.

In deciding which development projects to finance, the development banks are influenced by government goals and policies and by financial criteria. Governments exercise pressure on the banks to finance particular projects expected to benefit target groups. Once this is decided, the banks must seek funds to implement such projects. However, the lower the expected monetary return of the project, the more difficult it is to get the funds to finance it. To the extent that the government wishes to reach certain political targets and groups, it will increase the level of subsidy, and/or the pressure to get external-low cost funds. While fulfilling these functions, a development bank becomes a mere conduit for funds and less of a financial intermediary.

The above functioning of development banks has been criticized. The criticism is more severe on public development banks than on private or mixed capital development banks.[1] To the extent that the bank leans more towards private ownership, profit and hence monetary return on projects, becomes a more important criteria in project financing. In this regard Kane [1975] concludes that public development banks therefore, make a more significant contribution to economic development than private banks. This assertion is questionable in the long run,

when banks with low earnings have a slower growth as a function of their financial performance, and hence the need for continuous subsidies.

This discussion is indicative that development banks intend to operate as banks within the limits imposed by political constraints and institutional design. They are concerned about earnings while fulfilling development goals; hence at the difference of commercial banks, profit per se is not the motive in development banking.

Institutional Design of Agricultural Development Banks

In a political context, ADBs are an instrument of government policy for agriculture. As such they should serve particular groups of producers, usually the small and medium commercial farmers, while excluding the smallest subsistence farmers. They supply credit for crops that have high priority, either as part of food supply programs or for those that provide the basic foreign exchange earnings. They are characterized by very large operating costs, because of the type of clientele they serve. Finally, as a general rule, they have poor loan collection performance, which reduces even further the earnings margin or makes it negative, hence the permanent need for government subsidies.[2]

There has been a strong belief that ADBs as well as other development banks, should be specialized institutions. In fact it is possible and rational for an ADB to specialize in lending

to the agricultural sector; but that is not to say that the bank should specialize in being a lending agency and not playing the role of a financial intermediary. This misconception has led to the design of institutions with a very peculiar structure.

Many Agricultural Development Banks are very specialized institutions. Von Pischke, Hefferman, and Adams [1981] refer to them as "specialized farm credit institutions." The great majority of them are publicly owned banks, limited to offering farmers low interest rate loans, but no other financial services. They do not accept checking and savings deposits, provide money transfer services, store valuables for safe-keeping or serve as fiduciaries. Therefore, their only sources of funds are: a) loan recovery, b) domestic borrowings from the Central Bank, and c) external borrowings from International Financial Agencies, usually at very low rates and long deferment and repayment periods.

The limited sources of funds for these institutions inhibits them from acting as financial intermediaries. Von Pischke [1981] suggests that the limited capacity to access market funds results in alienation of the institution, because it can not intermediate between rural savers and borrowers, and it limits itself to serve as a link between the government and the rural sector. On the other hand, this institutional design and the high operating costs do not allow the bank to offer good quality credit, hence the farmers' preference for rural private lenders [Ladman, 1981].

A significant portion of the financial resources for agriculture is provided, however, by non-specialized (public, private and mixed ownership) development banks. Because of the structure of their asset and liability portfolios, these institutions have better possibilities for acting as financial intermediaries. Yet, they are subject to the same financial policies towards agriculture, particularly the provision of credit at interest rates below market rates.

The diversification of these institutions exists in terms of the sources and uses of funds. On the liability side they look much like commercial banks, since they borrow from internal and external sources, and receive demand and time deposits. On the asset side they serve various sectors (although they may concentrate on agriculture). They invest in securities and issue loans of different maturity and risk, hence allowing for more flexibility in the management of the portfolio.

In a recent analysis of the portfolio composition of 97 development banks in Latin America, Pomareda [1982.b] found very peculiar characteristics of those banks serving primarily or exclusively the agricultural sector (see Table 1). Banks with over 90 percent of their resources allocated to agriculture were exclusively public banks; they were smaller than the other banks and they depended fundamentally upon internal resources. The most significant contribution to the later was public borrowings. The proportion of public deposits in their portfolio was around 3 percent compared with 40 percent for other banks.

Table 1. Average Financial Structure of Development Banks in Latin America, 1975-1980

Variable	Percentage of Resources Allocated to Agriculture			
	0-10	10-50	50-90	90-100
Number of Banks	53	43	13	9
Percentage of Public Ownership	58.26	55.60	75.54	100.00
Total Assets (Million $)	826.94	1.239.356	3.159.136	92.055
Structure of Resources (%)	100.00	100.00	93.00	99.56
Capital	24.83	19.69	29.74	48.89
Internal Sources	62.70	65.37	59.89	42.07
External Sources	12.73	15.67	8.76	8.59
Distribution of Internal Sources (%)	100.00	100.00	100.00	100.00
Bonds and Values	10.22	11.28	2.60	2.49
Public Deposits	35.69	36.59	47.40	3.14
Public Borrowing	34.78	35.46	32.25	52.46
Private Borrowing	5.91	5.84	4.77	15.13
Other	13.40	10.83	12.98	26.78
Allocations by Sector (%)	100.00	100.00	100.00	100.00
Agriculture	2.47	27.65	66.82	98.13
Industry	38.85	34.66	14.05	0.00
Commerce	5.22	3.67	1.98	0.00
Construction	23.98	8.41	3.13	0.31
Other	29.48	25.61	14.02	1.56
Total Contribution of all banks to Agriculture (Million $)	884.41	4.856.76	11.502.53	658.98

Source: [Pomareda, C., 1982.b]

Note: It excludes the Banco de Noroeste de Brasil, the largest development bank in Latin America.

The discussion presented here suggests that the ADBs have much to gain from acting more as financial intermediaries. This is to say that the banks can restructure the composition of their assets and liabilities, but still specialize in lending to agriculture.[4] A bank could even charge low rates on certain agricultural loans, if it can earn more in its role as financial intermediary by issuing checking and savings accounts and investing on securities.

Financial Policies Towards Agriculture

As part of the same philosophy of finance for development, interest rates for agriculture are below market rates. Most developing countries provide subsidized interest rates to agriculture, with the main purpose of inducing the adoption of capital intensive technologies that would result in increased productivity. Low interest rates have been visualized as a necessary condition for agricultural development, yet much controversy exists on the subject. Besides the criterion of "low interest rates to induce technology adoption," several other arguments are offered to justify this policy. Some of these arguments are discussed below.

Low interest credit is offered as an alternative to high cost funds supplied by informal lenders in the rural markets. These groups are believed to exercise monopoly power, and hence, to receive returns above their costs. Nevertheless, informal lenders usually offer to farmers other services like input suppl

and a guarantee of purchasing the harvest [Barton, 1977; Bouman, 1979], hence justifying a higher cost of capital. On the other hand, the high cost of informal credit, usually delivered at the farm, may not be higher than the real cost of official credit which includes the farmer's time until the credit is obtained and during the loan supervision period [Adams, 1981]. In many cases, however, these intermediaries do exploit the opportunities in the rural sector and exercise monopoly power, particularly among the less fortunate farmers who do not qualify as credit worthy according to the ADB criteria.[5]

Perhaps, the strongest argument for low cost credit has its roots in the historical time when development policies were originally designed. The development philosophy gained strength in the 30's when the world recession implied negative real rates of interest. Therefore, it did not seem strange to offer development finance at 2 or 3 percent interest rates. However, if we focus on real rates of interest, the rate on the loan should include at least the cost of inflation, hence higher rates. Failure to do so will result in decapitalization of the banks. Such has been the case for many Latin American countries, which failed to reconcile their financial policies and current inflation rates [Galbis, 1981].

When inflation was not so severe and when international financial agencies had a stronger position, they could lend at very low rates. It was believed therefore, that domestic

development banks should provide farm credit at the same rates. That, however, ignores the administrative costs of credit because of the rather large number of small loans. If ADBs act as banks, they may have the right to transfer those costs to the borrowers. But also, if they act as instruments of government policy, then they can expect government subsidies.

The higher the cost of capital, the lower the expected profitability of the financed enterprise, and hence, a smaller margin to the farmer. Profit is a determinant of loan bearing capacity; therefore it is believed that lower rates increase profit margins, and hence, loan repayment ability. Low rates, however, induce misuse of credit obtained for agriculture but invested in alternative projects. As a result, a farmer could be an excellent payer to the bank because of higher returns to the borrowed money put in other uses, but not because of a larger profit margin in agriculture.

One of the strongest and most debated arguments for low cost credit to agriculture is the income distribution effects, expected to benefit the rural poor. This, however, assumes larger benefits to be distributed among a large number of small producers [González-Vega, 1977, 1981]. In practice, however, even though ADBs show a large number of loans, the number of beneficiaries is much smaller. The reason for this is that loans are provided on a crop-site basis. Hence, a large commercial farmer, with several properties and growing various crops, may

receive 5 or more of the largest loans, while small farmers receive one or at the most two small loans.

Much debate still exists on these issues. Many governments in Latin America are in the process of revising their interest rate policies for agriculture in order to keep institutions financially viable, and able to manage in the current inflationary process [ALIDE, 1981]. Nevertheless, there are some countries willing to continue subsidizing agricultural credit for political reasons. Low interest rates to agriculture may be claimed nowadays to compensate farmers for an unfair externally influenced rise in input prices and low domestic product and export prices, which reduce farmers income.

In the case of countries where inflation has been low for a long period of time but suddenly becomes a major drawback on the economy, its psychological effects may be more pervasive on credit demand than anticipated. When interest rates rise rapidly they have a strong effect on decreasing desired investment, and hence, on the demand for credit. A case in point was recently observed in Costa Rica (January 1982). When official interest rates rose from 12 to 20 percent, to adjust partially for inflation, the demand for agricultural credit declined temporarily. This effect lasts while farmers' expectations adjust and until they began learning to live with inflation, a process which is still underway.

While subsidized interest rates may not be justified from a financial point of view, there are other reasons why at a particular point in time agricultural interest rates may need to be low. If that is the case, the banks should then be prepared to supervise agricultural credit, for farmers to use it in the desired investments and not outside agriculture. However, this increases the banks' operating costs. In this case, the ADBs should be prepared to generate financial resources from other activities, in order to allow themselves to fulfill their development goals.

Nevertheless, if it was agreed to ~~increase interest~~ rates, an issue of relevance is the responsiveness of farmers to higher interest rates. It is argued that the elasticity of demand for public credit is rather insensitive to changes of the nominal interest rate, because the later is only a small portion of the total cost of credit the farmer faces [Adams, 1981]. Furthermore, this sensitivity could decrease if better quality loan services are provided and larger volumes of credit made available.

An interesting paradox exists on interest rate policies and agricultural risks. Low interest rates to agriculture have been justified from the farmers' point of view, because of high risk-low profit of agricultural enterprises. Low interest is therefore, expected to compensate for the cost of risk. However, from the bank's point of view, as a financial institution, it should charge a higher interest rate on loans to the

riskier enterprises, i.e., a higher rate for agricultural loans. This paradox and the naturally expected high default on agricultural development bank loans, is an important reason for the ADBs limited growth when they depend on their own resources. Further discussion on this issue is contained in the following section.

Risks in Agricultural Production and Loan Repayment

The Nature of Risks in Agriculture

Agriculture is a risky enterprise and risk averse behavior among agricultural producers has been given as one explanation for low investment, limited technique adoption and the slower growth of agriculture compared with other sectors. The situation is more severe in developing countries, where other factors aggravate the effects of risks.

Risk in agriculture stems from various sources. First, uncertain input supplies and prices make production costs a random variable. Second, uncertain yields and product prices imply risk on gross returns. There are also risks because of storage and marketing loses that the farmer often has to sustain. In order to manage risks, farmers adopt different strategies, including crop and technology diversification, reluctance to use modern inputs and credit, and the use of agricultural insurance.

Uncertain input prices are not widely recognized in the literature as a primary source of risk. However, experience shows that to avoid crop damage from unexpected diseases or pests, farmers will rush to purchase insecticides and fungicides and if there is panic, prices will rise to very high levels because of short term inelasticity of supply. The use of insecticides and pesticides can reduce risks. However, Just and Pope [1979] have demonstrated that a risk averse farmer will tend to overinvest in such inputs and this can be just as socially inefficient as under-investing in inputs which increase risks (as fertilizers). There is also often the case that in spite of the farmers' willingness to use certain inputs as part of a modern technology, these can not be obtained. In fact the success of some rural change and development projects has been guaranteed thanks to the provision in kind of those inputs. Such situations have been reported by Scobie and Franklin [1977] in Colombia and by Ccama and Pastor [1982] in the highlands of Bolivia.

Yield variability is a common source of risk and it is as significant in the arid environments as it is in the humid and subhumid tropics. It is usually associated with hail, frost, drought, fire, dust storms, hurricanes and river floods. Also, diseases and inappropriate use of technologies can result in loss. Yield variability associated with climatic factors is widely documented in the agronomy and agricultural economics literature, as shown for example by Anderson, Dillon, and

Hardaker [1977]. Yield variability associated with higher levels of input use is also evidenced in the works of de Janvry [1972] and Moscardi and de Janvry [1977]. Yield variability is an important reason for low rates of technology adoption as explained by Berry [1977], Green [1978], and Binswanger [1978]. The risks of agricultural production emerging out of yield variability have provided the rationale for crop insurance. This system has been widely extended in the developed countries and its potential in developing countries will be discussed in the following sections.

Price risk has been given greater attention in the literature, particularly in developed countries. The U.S. agriculture price programs are an indication of the importance of the issue. The income stabilization effect of price support programs in U.S. agriculture was recently examined by Baker and Dunn [1979], and Gardner [1979]; concluding that such programs affect positively the financial viability of farms.

Much of the research on price variability has been with regard to its effects on consumers welfare, as reported in the works of Waugh [1944], Subotnik and Houck [1976], Masell [1969], Just et. al [1977], among others. On the producers side, the desirability of price stabilization has been demonstrated by Hazell and Scandizzo [1975], among others. Agricultural price stabilization programs in national and international schemes have been widely advocated. However, few of these have operated

effectively because of their large costs and lack of political feasibility (Hazell and Pomareda, 1981).

This analysis suggests that there are several sources of risk in agricultural production and similarly several ad-hoc ways of handling them. Clearly, agricultural insurance is only one way of contributing towards the stabilization of farmers' income when yield failure occurs. Furthermore, the effectiveness of agricultural insurance as an income stabilizing policy would be affected by the correlation between yield and price variability.

Income Stability and Loan Repayment

The allocation of financial and physical resources at the farm level can be examined with references to Figure 1.[6] Following the principle of money fungibility, the different money sources are aggregated into a capital input, which is in turn assigned to various production processes according to the farmer's decision criteria.[7] Farmers, especially those that are smaller in terms of income, usually combine the earnings from several activities in one account and use those resources for the most pressing needs. The latter, of course, include present consumption and uses outside agriculture, both favored by the low interest rates at which official agricultural credit is obtained.[8]

Money is used to purchase agricultural inputs and, as discussed before, here is the first origin of risk. In addition,

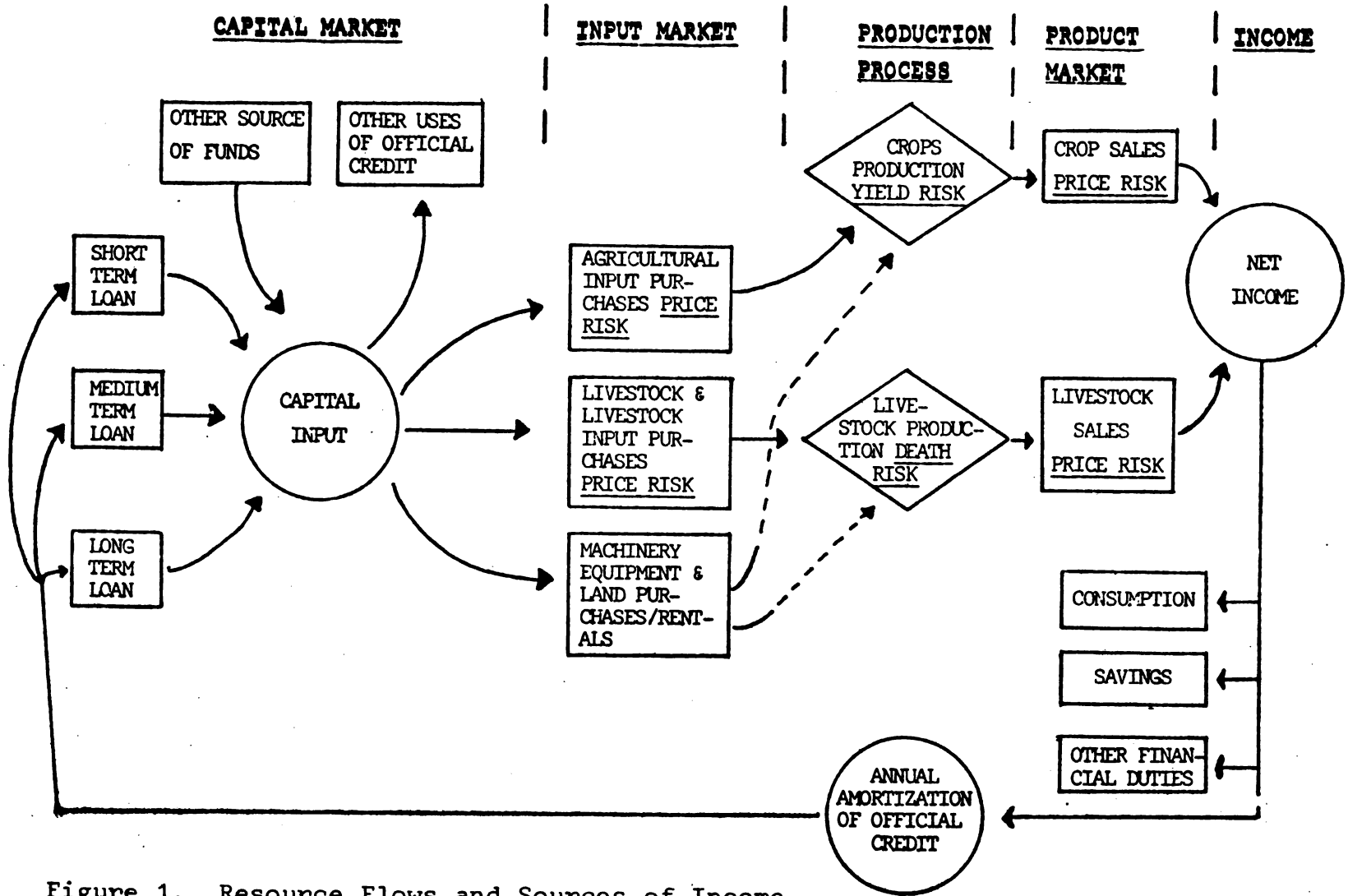

Figure 1. Resource Flows and Sources of Income Instability

it is important that inputs are used at the optimal time, because this affects vulnerability of crop yield to the variabilities of climate. Climatic yield variability can produce a total crop loss in all or part of the total area grown, or it can be partial loss in the total area. The last source of risk in the cycle is market risk, reflected in the instability of prices.

With reference to Figure 1, it is clear that net income (at the far right of the diagram) is a random variable. More over, beyond this point are additional elements that determine the available funds to repay the bank loans. Farmers allocate net income into planned consumption, savings and payment of outstanding debts. It is common to find that farmers would engage in luxury consumption even before paying outstanding debts, or else that present consumption is given greater importance than future consumption (savings). In any event, there are only exceptional cases when the banks intervene in product sales to guarantee recovery of the loans. This could be the case when the products are commercialized through a government owned marketing agency.

This process of the allocation of capital, plus the risks faced by the farmer at each stage of the process, explain why farmers may be unable or unwilling to repay their loans. The banks' awareness of this process for each individual borrower would provide the basis for loan provisions. However, the bank can not do much to improve the position of those not qualifying

for loans. The bank can, however, request government action to supply inputs at the opportune time and to provide support to input and product prices or the provision of agricultural insurance. All of the above would contribute towards a higher and more stable income.

This simplified analysis of income variability at the farm level provides the rationale for income stabilization polices of different kinds. However, a point worth emphasizing is that farm income can be stabilized and that should increase the farmers' debt repayment capacity. Yet, the removal of all income variability by itself does not guarantee loan recovery, because possible moral risk, which is induced in part by a higher opportunity returns from diverting low price credit to alternative uses.

Agricultural Insurance and Credit Insurance

As discussed, farmers confront numerous risks throught the growing season. Within this array of risks, there are specific measures and policies to deal with each one. Agricultural insurance has been devised with the specific objective of compensating farmers against yield failure. By purchasing an insurance policy the farmer protects the value of his crop harvest or animal against specific disasters. In principle the coverage can be for as much as 100% of the value. Expected product prices are used to calculate the value of the output or the total coverage.

Agricultural insurance schemes are widely difused in the developed countries. The U.S. Federal Crop Insurance Program has more than forty years of experience and covers more than thirty crops against most natural disasters (hail, drought, flood, fire, and others). Long existing programs are also in Canada, Sweden, Israel, Japan, and Australia. In the developing world, agricultural insurance is rather new, except for Mexico and Puerto Rico where the programs exist since the 1950's. Of all the programs referred to above, only the case of Mexico is a credit insurance program.

Credit insurance is slightly different than agricultural insurance. It protects only the value of the investment and not the total value of the harvest. By purchasing a credit insurance policy, the farmer protects his loan or a portion thereof. If the harvest (or part of it) is lost, or if the animal dies, the insurance agency pays the bank the amount due by the farmer, thus allowing him to return to production without seriously decapitalizing his resources.

On theoretical grounds, one can discuss the benefits of credit insurance from various points of view. Some of these benefits as well as the costs have only recently begun to be tested [Pomareda, 1981.a; Ccama and Pastor, 1982; IICA, 1981]. Credit insurance pays the farmer's debt in the event of yield loses. By doing so, it stabilizes the farmer's income and increases his debt bearing capacity. By paying his bank debt, it allows

the farmer to return to the bank in the following year and request a new loan and continue investing. Within the agricultural system, insurance spreads risks among farmers, regions and crops over time and it precludes the need to expensive ad-hoc disaster efforts, as the insurance system itself is able to offset losses from the reserves collected in good years and in unaffected areas.

Although highly favored as part of a rural development strategy in developing countries [Ray, 1974; Tewari and Sharma, 1978; Koropecky, 1980; and Gudger, 1980], crop insurance has been questioned on two grounds. First, its justification is questionable when the variability of yields is small and when traditional methods of risk management prove to be effective. Second, its feasibility is limited by its costs, particularly if premiums may need to be too high for the program to be financially self sufficient or else need to recur to government subsidies [Roumasset, 1979; Crawford, 1979]. The later point has been a major reason for debate with regard to agricultural insurance and agricultural credit insurance. The concern is valid, particularly when considering that agricultural development banks (especially those servicing a large number of small farmers) engage in large administrative expenses. An insurance agency servicing the same clientele will face similarly high operation costs and, therefore, it could also require government subsidies.

A third issue, directly relevant for credit insurance, rests on the reasons for loan defaults faced by the banks. Loan default may be due to low incomes, because failure of the marketing system which results in low products prices, or high input prices or lack of inputs, or due to moral risk. In those cases few arguments can be made for the benefits of credit insurance. However, credit insurance would be useful if loan defaults are due to income instability because of production losses.

Since the feasibility of insurance is highly affected by its costs, a word is important on this regard. In the analysis of costs of insurance, two distinct components of costs are to be examined. First, the administrative costs, could be decreased by an appropriate composition of the insurance agency portfolio in terms of size of farms and regions.[9] Second, the financial costs, (i.e. premium/indemnities ratio), could be managed through the composition of the insurer's portfolio. In this case the insurance agency could structure a portfolio with various crops for which loses are not expected at the same time.

Given the costs of risk in agricultural production, commercially issued insurance is usually considered too expensive for farmers to purchase. It would in addition be too expensive because premiums are calculated solely as a function of expected loss and variance of loss, disregarding the covariance between the various items in the portfolio. For an insurance

program servicing agriculture for development purposes, the objective of the institution is not necessarily the maximization of profits, but rather staying financially viable while serving farmers at the lowest cost. Within such objectives, it could be possible to run self-financed insurers that exploit the insurance and investment alternatives through a portfolio management approach [see Pomareda, 1981.b; Arcia, 1982]

To conclude, agricultural risks make farmers income stochastic, decrease debt bearing capacity and hence result in low loan repayment. However, stabilizing farmers income is not a guarantee of loan repayment. If, on the other hand, credit insurance is demanded, it would guarantee loan repayment to the bank only when yield failure is the reason for income variability. The effects of credit insurance on the supply of credit are examined later on in this chapter.

Administration of the Loan Portfolio

Introduction

It is evident that there are conflicts of interest and policy in agricultural development banking. These emerge from the philosophy of financing risky agricultural production at the lowest rates of interest. Furthermore, managing an ADB is highly exposed to political decisions that have important consequences for the bank's growth, and hence, for the supply of credit. Although managing an ADB goes beyond management of the

loan portfolio, this point is discussed here because of its importance in the mechanism of the supply of credit over time.

This may be taken as the case of a rather specialized ADB. On the asset side the bank is assumed to issue only loans of different maturity, size, expected return, risk of return, and demand for bank's human and physical resources. On the liability side the bank could engage in short and long term borrowing from the Central Bank, from commercial banks (with government subsidy), and from international financial agencies. The bank may also receive direct government subsidies

This rather simple composition of the balance sheet is typical of many specialized ADBs. This, however, takes an extreme position, because some banks have, on the asset side, small amounts of cash, securities (bonds), real assets and some fixed assets. Also on the liability side, some ADBs handle demand and time deposits on some pending accounts and net capital.

The Loan Portfolio: Administration Costs and Recovery Rates

Because of the nature of ADBs, their loan portfolio is typified by high costs and low returns. High total costs are the result of a large number of loans that the bank has to issue and administer. Low returns are due to low nominal rates and high default or, in other words, poor loan collection performance. This section analyses the interrelations among these concepts.

The loan portfolio is structured by loans issued for different purposes and of different sizes, maturity and risks. Although other development banks finance mainly large projects, ADBs finance mostly production loans for short cycle crops and cattle fattening, and a more reduced number of loans for investments like orchards, cattle herds and farm improvements Although a significant proportion of the resources is allocated to a small number of large loans, the bank still has to administer a large number of small loans. Because most of the small loans are for annual crop production, their maturity is of less than one year, regardless of the size of the loan. A small number of loans however, may be of longer maturities, particularly the investment loans. As the bank diversifies by regions and crop cycles, there is likely to be a difference in the risk characteristic of loans, yet this may not always be the case.

The bank issues loans of different characteristics in response to farmers' demand, the availability of financial resources and following government policies. The allocation of funds is rarely made with a simultaneous consideration of the availability of physical and human resources. As a result the bank has to administer loans beyond its capacity, which in turn contributes to poor loan supervision and hence increased delinquency rates. This overloading of the banks' administrative capacity has also been suggested as the main reason for a poor service and hence unsatisfaction of the farmer.

There are however important relationships and trade offs between financial policies and bank resource availability, as discussed next. Assume that a loan of size L is charged a nominal rate of interest r, hence the interest earning is

$$R = L \cdot r. \tag{1}$$

Therefore, at maturity the bank would collect:

$$\tilde{L} = L(1+r) = L+R. \tag{2}$$

In fact however, the bank works with expected values on loan collection, which implies that the net recovery i.e., the proportion collected of each loan at maturity is

$$E(\tilde{L}) = \gamma[L(1+r)] \tag{3}$$

where γ is the recovery rate. The above suggests that the bank can increase expected loan collection in two ways. First, by increasing the nominal rate of interest, which is fundamentally a political decision. Second, by improving the loan recovery rate, which is however, a managerial issue, and hence the bank can alter it by increased loan supervision or through credit insurance.

Most bank officers would agree that increased loan supervision provides increased loan recovery at a decreasing rate. Nevertheless, the nature of this response function would be different for various groups of farmers, the crops grown

and the risks to which the farmer is exposed. It is clear also that to provide more loan supervision, within the available physical and human resources the bank would have to decrease the number of loans issued. If the bank moves more towards private ownership (becomes more concerned with profit and least cost solutions) one can expect a decline in the number of small loans and the enforcement of strong loan selection criteria.

On the other hand however, if an ADB had the option, it could reject certain loans because historical experience shows them providing too small gross returns, or because of too high costs. Yet, as the bank leans more towards public ownership it is not likely to be able to practice much loan selection policies but to take those loans that are expected to fulfill government polices.

Lending costs have two important components. First there is the cost of issuing and suppervising a loan until maturity. Second there is the cost of keeping on the books and prosecuting a loan that is overdue. These costs are expected to be the same regardless of the amount lent, although there could be small differences in costs, depending on the purpose of the loan and its maturity. Long term livestock loans for example, may have a larger issuance cost, but in general a low administration cost while the loan is outstanding. Administration costs could also be different for areas with different accesibility.

Managing the loan portfolio is a central issue in agricultural development banking. The bank can improve its loan selection and supervision procedures and upgrade and enlarge its staff. Yet, there will be a limit on improvement on loan collection, beyond which little can be gained by investments on improved management. If the reasons for default are the risks in agriculture, then income stabilization programs would provide more direct benefits. Alternatively, credit insurance could also be demanded.

Credit Insurance and Loan Recovery

Although much has been mentioned about goals in development banking, no specific criteria has been given yet for the institution's objective(s). On this regard the author believes that there is no such a thing as a single objective in development bank management. However, banks in general, and ADBs are no exception, can be considered as utility maximizers in the sense that they trade risk for return. As such, the institution's board of directors would act as risk averse a la Baumol, i.e. the risk of return is given a certain weight in the decision-making. This would depend on forecasted situations and the current financial position of the institution. In other words, the institution can be assumed as maximizing a linear objective function with parameters as follows:

$$U = E(\pi) - \phi \sigma \qquad (4)$$

where:

U, is utility,

$E(\pi)$, are expected returns over a multiperiod horizon,

ϕ, is a constant risk aversion parameter,

σ, is the standard deviation of returns over a multiperiod planning horizon.

In the extreme cases of a fully supported-government guaranteed institution, ϕ would be zero, yet that may exist only in a very hypothetical situation. As risk aversion increases, the bank would prefer to invest in the most secure loans, i.e. those with the highest recovery rate. Hence, the opportunity cost of credit insurance is expected to rise as the banks become more concerned with risk management. In other words, credit insurance becomes more desirable when the ADBs depend more on their banking capacity, than on their bargaining ability to obtain government subsidies to cover up for loses. As the availability of government funds becomes more limited, ADBs will benefit from requesting farmers to take credit insurance. This would allow the banks to fulfill development goals, even without changing their internal management and financial policies.

This is not to say, however, that credit insurance is justifiable on all grounds; but that it could be considered as an alternative, if credit supply is to reach potential viable farmers exposed to risks in production. Such farmers are viable

in terms of their average productivity. Therefore, credit insurance provides them with a guarantee of loan repayment when, for reasons beyond their control, they could not pay back their loans.

There is evidence that agricultural credit insurance provides direct benefits for the lending institution. The insurance agency pays the bank the farmers' debt when farmers income is reduced because of crop yield failure, animal death or loss of function. In Panama in 1979 and 1980 the Agricultural Insurance Institute (ISA) payed the Agricultural Development Bank (BDA) indemnities for US$194,642 and US$402,143 respectively, which allowed for a significant improvement on loan recovery (ISA, 1981). The loan recovery rate for industrial tomatoes for example, was improved from an average of 82 percent between 1976 and 1978 to 95 percent in 1979 and 99 percent in 1980 [Pomareda y Fuentes, 1981].

Other advantages of credit insurance to the lending institution could be the reduction of costs of "farmer hunting" to collect the delinquent loans, and the additional supervision for the most optimal use of credit. The insurance supervision program helps the bank to separate those farmers that do not want to pay from those that can not pay. For the latter group the insurance agency will pay the bank the amount due by the farmer. However, since credit insurance provides coverage only for yield losses, its protection is only partial, because

farmers can still have reduced incomes because of excesive costs of production or low product prices. Credit insurance would therefore, provide the largest benefits for the bank when lack of loan repayment is due mostly to yield failure.

It should be pointed out that although credit insurance allows the bank to show a healthier loan portfolio, it could be interpreted as a cover up for the bank's low capacity to recover its loaned funds. In this sense credit insurance does not offer an incentive for the bank to improve its loan selection procedures and inspection practices to increase loan recovery. However, it is a way of improving loan recovery and it should allow the bank to grow at a faster rate. Its desirability is clearly high for the bank, yet its justification is to be based on cost effectiveness; i.e. whether the overall costs to the bank and the insurer do not exceed the benefits.

An issue for debate still remains. If credit insurance compensates for losses in agricultural production and therefore stabilizes farm incomes, then there should be no reason anymore for such highly subsidized interest rates. With credit insurance therefore, agricultural development banks could charge higher interest rates to farmers. The net effect on the bank would therefore, be a higher recovery of loans and higher interest earnings. Under such scenario, should it be the farmers who pay the cost of insurance or should it be the bank who pays for it?

From the viewpoint of the farmer, who is used to paying a low price for credit, it is unlikely that he would be very willing to pay the cost of insurance and a higher interest rate. On the other hand, if credit insurance provides direct inmediate benefits for the bank, it may be reasonable to think that this institution should help to pay for the cost of insurance. This is an issue for further research; but to estimate the maximum benefits of insurance for the bank it is assumed in this work that the bank does not pay any of the insurance cost.

Asset-Liability Management and Credit Supply

The Determinants of Bank Behavior

This section examines decision making of the banking firm by focussing on the factors that determine bank behavior. The analysis relates the decision making framework to the elements of portfolio theory discussed later.

The behavior of the banking firm is determined by its objective or set of objectives; its available options or choices for sources and uses of funds; and the restrictions imposed by technology, physical inputs, laws and/or regulations. Decision making within such a set of objectives, alternatives and restrictions is a complex process and serious attempts have been made to model it. The modeling efforts, although they are abstractions and have limitations, have also shown to be of practical

use in helping to build a theory of the banking firm and in assisting decision makers.

The decision unit within the organization, whether an individual or a board or directors, provides guidance and exercises control, yet it is not expected to have full domain of every operation. However, its decisions are expected to maximize the organization's objectives. Such objectives are related to management interests as well as to ownership ones. Furthermore, in development banks such objectives are definitely related to government policy. Defining the institutions' objective is a difficult task, in part because no single objective can be specified. It is perhaps more proper to think of a financial objective as the maximization of expected utility and a set of goals. The institution establishes goals in the short and long run. Through the maximization of objectives, the institution pursues goals mainly in terms of size and growth. The later suggests that decision making is a dynamic-constantly adjusting process. Yet, as it is commom in economic theory, we begin with a static situation or a so called equilibrium situation.

The alternatives for sources and uses of bank funds are selected from a wide set of possibilities, following the institution's goals and within the governmental rules and regulations, state and federal laws, and banking agreements. Hence, given a set of assets and liabilities, the bank will choose among them trying to satisfy its objectives.

Banks behave within technical and legal constraints. The latter are imposed by the Central Bank authorities and the Bank Commissions. These constraints vary by country and by regions within a country, according to the particular characteristics of the bank. One of the main restrictions on bank portfolio behavior concerns deposit and reserve requirements. Legal restrictions affect bank behavior in relation to allowance to invest in common stock of non-bank enterprises, size of loan operation, payment of interest on demand balances, underwriting of corporate debt or equity instruments and levels of interest rates.

The constraints in general can have positive as well as negative effects on the bank's behavior. It has been suggested that "these regulations effectively prohibit a number of otherwise attractive portfolios and therefore tend to impede banks from maximizing their objective functions. On balance such regulations probably lower bank profits, strenghten the hand of ownership interests relative to management, and force banks to have portfolios that lessen the probability of bank failure" [Hester and Pierce, 1975; p.18].

Physical constraints are important for a bank as for any other firm. Objectives can be maximized only within the availability of inputs such as labor, building capacity, computer time, telephone services and, in the case of banks servicing the agricultural sector, the number of vehicles and field staff

to make credit supervision. The opportunity cost (or shadow price) on these constraints are the best indication of the need to modify them, particularly when planning the firm's growth.

This introductory section has presented the elements for decision making in the banking firm. It can be inferred that knowledge of objectives, alternatives and constraints provides basis for modelling the bank's decision making process, following the principles of portfolio theory. This, in summary, provides the rationale for holdings of alternative assets and liabilities on the basis of their expected return, their variance of return and the covariance of returns among them.

Before closing this section two points deserve further emphasis.

The first refers to the fact that proper bank management goes beyond the structure of the bank portfolio. Jessup [1980] points out that the consideration of cash flows, time deposits, loan decisions and reviews, projecting growth, managing bank capital and other issues lead into complex decision making for sound, efficient and professional bank management. However, bank portfolio size and composition, in order to satisfy goals within the existing set of financial and physical constraints, is a very important determinant of successful bank management.

The second point refers to the time dimension in bank decision-making and its implications for bank portfolio management. The time variable is of singular importance when planning

bank growth, particularly when considering that the institution's goals go beyond annual profit maximization. Because assets and liabilities have different maturities the bank faces a basic problem of dynamic balance sheet management.

Managing the Asset-Liability Spread

Succesful bank management rests strongly on the management of the spread between assets and liabilities. Since development banks have enjoyed a preferential treatment, the cost of funds has been low; thus allowing them to hold assets (loans) of relatively low profitability. Yet, as the cost of funds becomes increasingly high, there seems to be no other alternative but to inject more profesionalism in the management of bank funds. This may allow the bank to continue providing development services at the lowest possible cost.

For simplification purposes the analysis in this section abstracts from the other two important aspects of bank management liquidity and risk, to concentrate on return i.e. the spread between assets and liabilities. We analyze the cost and the revenue components of net earnings.

Financial costs in period t, $(FC)_t$, are defined by the interest and amortization payments on the banks contractual debts and interest payments on deposits from the public.

$$(FC)_t = \sum_k (b_k B_k)_t + \sum_k (A_{kt}) + (d_t D_t) \qquad (5.a)$$

where:

b_k , is the nominal rate on borrowed funds from source k.

$(b_k B_k)_t$, is interest expense due to source k in period t.

A_{kt}, is the amortization of borrowed funds from source k, due in period t.

d_t , is the interest rate paid on deposits in period t.

D_t , is the volume of money held on the form of deposits.

With respect to borrowings there is no element of risk, as the bank arranges for repayment conditions in advance. The bank would choose from alternative sources of funds not only as a function of the interest rate on borrowed funds, but the length of the repayment period and the grace period, a typical feature of development funds. As far as time deposits, the risk of withdrawal will be expressed through a liquidity balance constraint.

Operating costs are a major determinant of bank net earnings. Furthermore, there are important trade offs between the availability and use of operating capital and resources and bank performance. Operating costs can be considered to include costs of personnel for loan appraisal and supervision and maintenance of deposit accounts, vehicles for field work, maintenance of office facilities, computer services, etc.

Operating costs, $(OC)_t$, would include the following components:

$$(OC)_t = H_t + V_t + O_t \qquad (5.b)$$

where:

H_t = personnel costs

V_t = vehicles maintenance and repair

R_t = other expenses including office facilities equipment and other.

The bank can increase the loan recovery rates through stronger loan selection procedures, hence rejecting those loans that do not qualify; or else rationing credit according to debt bearing capacity criteria. Doing this, however, implies a larger amount of time spent on each loan appraisal, and hence, a larger demand for bank staff. Similarly, loan recovery rates can be increased through more intensive loan supervision, which implies more continuos contact between the loan officer and the farmer; therefore, larger requirements of staff, more vehicles and more operating capital for vehicle fuel, maintenance and repairs.

In trying to save operating costs, the banks contribute to increased loan defaults. Yet, because of the rather large number of loans administered, the bank has no choice but to accept the operating conditions, and hence the resulting performance. For

better operating conditions most agricultural development banks in Latin America would have to increase and upgrade their staff, and increase considerably their operating budget, in order to minimize default rates.

With respect to the generation of income, the bank usually has the choice of loans, investments and real assets plus any cash holdings. Returns on these assets will determine the the banks' gross earnings, $(GR)_t$, as follows:

$$\sum_i N_{i,t-j} L_{i,t-j} + \sum_i [N_{i,t-j} r_i L_{i,t-j}]\gamma_i + \sum_i M_{i,t-j}(1+y_i)Y_{i,t-j} + S_t + C_t \qquad (5.c)$$

where:

$N_{i,t-j}$, the number of loans of type i maturing in year t and issued in year t-j, i.e. j is the period to maturity.

$L_{i,t-j}$, the size of a loan of type i, maturing in year t and issued in year t-j, i.e. j is the period to maturity.

$M_{i,t-j}$, the number of bonds of type i maturing in year t and issued in year t-j

y_i , return on bonds of type i

$Y_{i,t-j}$, principal of bonds at date of purchase in year t-j

S_t , returns on real assets

C_t , cash holdings

Therefore the bank's annual net return is determined by:

$$\pi_t = (GR)_t - (FC)_t - (OC)_t . \qquad (6)$$

The conflict of purposes in the management of agricultural development banks can now be more fully understood. On one hand, for development purposes within currently conceived philosophies, ADBs want to reach the largest number of farmers and provide them with the lowest price credit. On the other hand, the banks face high operating costs, low earnings, and very slim operating budgets. The result can not be other than a poorly performing institution characterized by high loan default and low quality credit supplied at low interest rate, but at a high cost to the farmer.

Dynamic Balance Sheet and the Supply of Credit

Bank portfolio management relies fundamentally on dynamic management of the balance sheet, i.e. decisions regarding the sources and uses of funds over time. This section develops the principles for the determination of the supply of loanable funds for the case of a specialized ADB.

The amount of funds that the bank can allocate in period t to loans of different characteristics, is limited by the availability of loanable funds:

$$\left[\begin{matrix}\text{loanable}\\ \text{funds}\end{matrix}\right] \leq \left[\begin{matrix}\text{loan}\\ \text{recovery}\end{matrix}\right] + \left[\begin{matrix}\text{bond}\\ \text{collections}\end{matrix}\right] + \left[\begin{matrix}\text{net}\\ \text{deposits}\end{matrix}\right] + [\text{borrowings}]$$

$$- \left[\begin{matrix}\text{financial}\\ \text{costs}\end{matrix}\right] - \left[\begin{matrix}\text{operating}\\ \text{costs}\end{matrix}\right] - \left[\begin{matrix}\text{other investment}\\ \text{securities and}\\ \text{bonds}\end{matrix}\right] - [\text{cash}]$$

$$\sum_i N_{i,t} L_{i,t} \leq [\sum_i N_{i,t-j} L_{i,t-j} (1+r_i)]\gamma_i + \sum M_{i,t-j} Y_{i,t-j} (1+y_i) +$$

$$[(TD)_t + (DD)_t] + (B_k)_t - (FC)_t - (OC)_t - \sum_i M_{i,t} Y_{i,t}$$

$$- C_t . \qquad (7)$$

Where all terms have been already defined.

Loan recovery in period t is a function of management and financial policies in previous periods, which directly or indirectly affect expected returns through the nominal rate of interest or through the loan recovery rate. Furthermore, time preference and resource availability will affect the issuance of loans maturing in period t, t+1, t+2... t+j. With fixed low interest rates and high inflation the bank would prefer shorter loans; however, longer maturity loans demand less fixed issuance costs per period because money is turned over less frequently, and hence, less paper work is needed. Therefore, when trying to optimize its resources, the bank faces a trade off between the value of money, the operating costs and the availability of physical resources.

Borrowings in period t are not exogenously determined. The bank is not likely to be able to borrow beyond its financial and administrative capacity, as appraised by the bank's administration and the lending agencies, either domestic or foreign. In addition, the leverage requirements and the overall composition of assets and liabilities will determine the optimum amount of borrowings at a given interest rate and repayment conditions. However, we could specify that there is always some upper limit on the amount of total borrowings.[11]

The bank would, therefore, select its sources of funds simultaneously with the decision on uses of funds, searching for the largest earnings margin, while fulfilling its development goals and servicing a particular clientele. In many cases, however, the bank negotiates the repayment conditions on borrowed funds depending upon the use to which the funds are to be put.

Financial costs in period t are determined by contractual arrangements in previous periods. Operating costs are defined in the previous section and they are not to exceed the institution's budget.

This analysis provides the rationale for bank growth and the supply of credit in each time period. It is evident that interest rate policies, borrowing strategies, management of

inflation; and allocation of physical and human resources are important determinants of bank growth. Simultaneous decisions on these issues will determine the bank's capacity to supply larger amounts of credit.

Differences in profitability, risk, maturity and resource requirements, will determine the allocation of funds to particular loans. These include various annual crops, perennial crops, livestock and farm improvements. However, the bank may be limited in its decisions by government legislation, institutional agreements and/or political pressure to guarantee the supply of credit for particular purposes. These restrictions would affect the bank's optimal resource use and aggregate credit supply; but they would, on the other hand, guarantee short term fulfillment of development goals. One could, with certainty, indicate that the nature of these restrictions provide the fundamental difference between the operating practices among commercial and development banks.

The central issue and main conclusion of this discussion is that an ADB that depends primarily on loan collections, can not grow as fast as a diversified bank; hence it needs government subsidies and or external low cost funds. However, for an ADB with most agencies located in rural areas, the point remains as to how could it attract time and demand deposits from rural residents-farmers and non farmers. The issue has been discussed in the literature of rural finance, but not as

much as the aspects of subsidized interest rates and related topics.

One explanation for the neglect of savings mobilization may be its inconsistency with policies of low interest rates on loans (Vogel, 1981) and the high costs of administering a large number of savings and checking accounts. In addition one must recognize that managing a bank with multiple functions is far more complicated than managing a lending bank which relies on donors' money.

For a bank to be able to attract time and demand deposits in rural areas, it has to offer a positive real interest rate on savings accounts. Without this, the rural population would utilize its traditional means of hedging against inflation (Vogel, 1981; Buser, 1976).

Set of Hypotheses

More financial resources are needed to allow for faster and equitable agricultural growth. To achieve such objectives, agricultural development banks are expected to play a more meaningful role by increasing the supply of credit. In achieving their targets, however, ADBs face problems of institutional design and policies that limit their performing ability. On the other hand, lending to agriculture continues to be a risky and costly enterprise.

This chapter has shown that ADBs could improve their overall performance, by functioning more like banks, while they fulfill development objectives. ADBs could diversify their asset and liability portfolios and this should increase their availability of funds and their capacity to act in a financially unstable world. This would be mandatory in cases when the governments can not provide more subsidies and when foreign soft loans dry out. Nevertheless, even with the best diversified and managed portfolios, the banks could still face significant default on agricultural loans because of production risks. Hence credit insurance should be considered, but not as a substitute for better management of the loan portfolio.

The main purpose of this study was to determine the impact of alternative policies on the supply of credit. However, because agricultural development banks are rather complex institutions, the various policies would have many other effects besides the changes in the supply of credit. Therefore, the analysis carried does not focus only on credit supply but also on various elements of importance in the decision making process, for selecting among alternative strategies. Furthermore, some important changes on the credit supply may be the result of external factors rather than policies controllable by the bank or by the government.

With these observations, the following hypotheses were tested:

i) Increased risk aversion on the bank's management, implying more concern for loan recovery, will have a positive impact on long term growth. However, the bank may be induced to reject loans that would have otherwise been part of its 'development oriented' portfolio.

ii) Credit insurance provides benefits for the bank through reduced costs of loan administration, higher average recovery and lower variance of loan recovery. These factors contribute to a larger availability of loanable funds and faster bank growth.

iii) Serving small farmers imposes a constraint on bank growth through higher administration costs and lower availability of funds. Hence relieving the agricultural development banks from this requirement will increase bank growth.

iv) Higher cost of funds borrowed from commercial banks and a decline in government subsidies will have a negative impact on the bank's growth and its capacity to serve small farm agriculture. The impact is aggravated by the fact that the bank does not have a diversified portfolio on assests and liabilities.

v) Transforming a specialized bank into one with multiple functions will allow the bank to increase its size and

the availability of funds. However, the growth of the supply of credit to agriculture could be affected by the relative profitability of loans versus other instruments and by the cost of funds.

These hypotheses were tested through analysis of sample information on loans issued in various years and by using a mathematical programming model. Although, these data came from only one bank, some important implications can be addressed for specialized agricultrual development banks in general, either in Latin America or in developing countries in other regions.

End Notes

[1]Public (private) banks are those in which all of the capital stock is owned within the public (private) sector and operating policy is under public (private) sector control.

[2]Poor loan collection is strongly influenced by political decisions when the government wants to benefit particular groups who claim crop disasters.

[3]Members of the Latin American Association of Development Finance Institutions (ALIDE).

[4]Loans of different size, maturity, risk and physical resource requirements.

[5]Many times the reasons the ADB gives for not providing a loan are the absence of ownership title, a plot that is too small or a technology adoption capacity that is unreliable.

[6]See Hanson and Thompson [1981] for a discussion and a simulation of farm debt bearing capacity as affected by income and variability of income.

[7]Von Pischke and Adams [1980] highlighted the primary implications of money fungibility in agricultural finance, particularly as it makes difficult to evaluate credit programs, where credit is usually treated as another production input.

[8]Ladman and Tinnermeier [1981] present an interesting description of such capital markets in Bolivia, where money borrowed for agricultural purposes is used in construction and other sectors, where returns are much higher.

[9]These may include farm loans issued by different banks.

[10]The concept of net deposits implies the available funds after meeting the leverage and reserve requirements.

[11]The amount borrowed is also affected by the possibilities for attracting deposits instead of acquiring debt.

CHAPTER III

A MULTIPERIOD MODEL FOR AN AGRICULTURAL DEVELOPMENT BANK

Introduction

The preceding discussion illustrates the nature of decision making for an ADB. It is evident that managing the portfolio is a complex process, yet possible to model in the context of a mathematical programming formulation. This is because the bank has an objective, alternatives and constraints. Furthermore, it is possible to model this decision making as a multiperiod system taking into account the intertemporal linkages that characterize the decision variables.

Portfolio theory offers the appropriate methodology for a quantitative framework that allows one to structure the interrelations discussed in the previous chapter. It also allows to integrate the principles of risk management and resource allocation for optimal composition of the bank's portfolio. After reviewing the principles of portfolio theory, this chapter reviews the main optimization models of commercial bank management.

Portfolio theory and commercial bank portfolio models are reviewed in the first part of the chapter. The remaining of the chapter develops a model for an agricultural development bank. The approach begins with the building blocks of an ADB model and then develops the multiperiod formulation. This is done through the use of a multiperiod linear programming model.

Portfolio Theory and the Banking Firm

Background

The general principles of portfolio theory are built on the concept that investors face a utility function of money. They would choose among alternatives on the basis of their expected returns and variance of expected return.

Whether the options are bonds held by a private investor, loans issued by a bank, policies offered by an insurance agency, or crops grown by a farmer, these options are subject to risk because their returns cannot be anticipated with perfect certainty. This implies the existence of an expected return associated with a probability distribution and hence a variance of returns. Moreover, nature does not affect the behavior of returns for each alternative in the same way; hence, there is some degree of correlation in the returns of the various alternatives. To the extent that this correlation is not perfectly positive, there are gains from diversification.

The objectives of enterprises are multiple. From a financial point of view however, two are common to all investors: a. to obtain the maximum return[1]; and b. this return to be dependable and stable i.e., subject to the least variation. It is on these two objectives that one finds an inconsistency i.e., the maximum return is not necessarily the one with the least uncertainty of return. The choice among pairs is a function of

the investor's performance; yet it is necessary to know which are the portfolios that provide a given return with the least uncertainty.

It has become established now to measure risk by the variance of returns. However, in portfolio analysis, the covariance of returns of alternative investments is as important as the variance of individual investments. In fact, it is because of the existence of such a covariance that risk can be managed through diversification. The general principles of portfolio theory go back to the origins of decision sciences, but it was only with the pioneering work of Markowitz [1952] that a mathematic formulation was made available.[2] Ever since its appearance, portfolio theory claimed interest among economists and financial analysts. The following two sections present the concepts of feasible and efficient portfolios and then the concepts of utility and optimal portfolios. The separate discussion of these concepts is necessary for a fuller understanding of portfolio management theory.

Feasible and Efficient Portfolios

A portfolio can be structured by one or by many investments,[3] each with its own characteristics. The selection of the best combination of investments given the investor's capital constraint is not an easy task. According to Markowitz, the choice is among those investments for which the maximum return is associated with a given variance of return. The locus of such

combination defines a set of efficient portfolios, i.e., the frontier in Figure 2. The combination of investments that for the same variance provides with smaller returns are located in the shaded area and they are defined as feasible but not efficient portfolios.

If the investor can allocate his financial resources into n investments, then the proportion of each one in the portfolio can be defined as X_i (for i=1,2..n)

$$\sum_{i}^{n} X_i = 1 \qquad (9)$$

and the feasible portfolios (including the efficient ones) fulfill the following non-negativity condition:

$$X_i \geq 0 \; . \qquad (10)$$

The expected return of the portfolio, a random variable in itself, is the weighted average of the expected returns of each investment ($\bar{R}$) hence

$$E(R) = \sum_{i}^{n} X_i \bar{R}_i \; . \qquad (11)$$

The covariance of return of the portfolio depends on the proportion of each component, its variance of return and the covariance of returns among investments.

$$\sigma_r^2 = \sum_i \sum_j X_i X_j \sigma_{ij} \qquad (12.a)$$

$$\sigma_r^2 = \sum_i \sum_j X_i X_j \rho_{ij} \sigma_i \sigma_j \qquad (12.b)$$

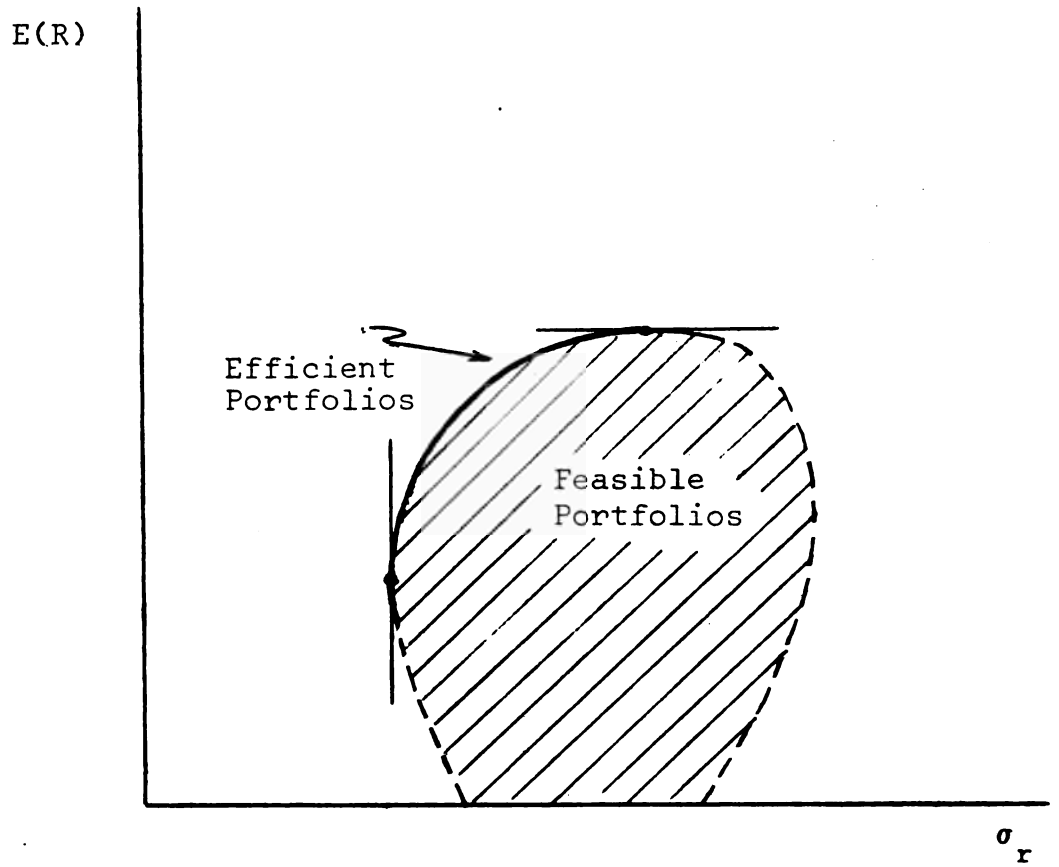

Figure 2. Feasible and Efficient Portfolios

where ρ_{ij} stands for the correlation coefficient among investments and σ_i and σ_j are the standard deviations of returns. In matrix notation the variance of return is:

$$\sigma_r^2 = [X_1\ X_2 \ldots\ldots X_n] \cdot \begin{bmatrix} \sigma_{11} & \sigma_{12} & \ldots & \sigma_{1n} \\ \sigma_{21} & \sigma_{22} & & \sigma_{2n} \\ \vdots & \vdots & & \vdots \\ \sigma_{n1} & \sigma_{n2} & & \sigma_{nn} \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \qquad (13)$$

The generalities presented above deserve further discussion to understand the role that each component (X_{ij}, R_i, σ_i and ρ_{ij}) play in the performance of the portfolio.

The proportion of each investment, (X_i) contributes linearly to the expected return and variance of return of the portfolio. Therefore, larger values of X_i will have more weight in the expected return and variance of return of the portfolio.

In the special case in which the portfolio is composed entirely of one investment, correlation is of no relevance. However, in the general case correlation is important and this can be seen by further disaggregation of equation (12.a)

$$\sigma_r^2 = \sum_i X_i^2 \sigma_i^2 + \sum_{i \neq j} \sum_j X_i X_j \rho_{ij} \sigma_i \sigma_j . \qquad (14)$$

The first term of the second part of equation (14) is obviously positive. However, if the covariance term is negative, it counter acts with the first and hence reduces the variance of the portfolio. The larger the degree of negative correlation in the portfolio, the larger the convexity of the efficient frontier.

It was Markowitz who first suggested quadratic programming to find the set of efficient portfolios. The problem reduces to:

$$\text{Min} - \lambda \left(\sum_i^n X_i R_i \right) + \sum_i^n \sum_j^n X_i X_i \sigma_{ij}^2 \qquad (15)$$

for all possible values of $\lambda \geq 0$ and

$$\text{s.t} \quad \Sigma X_i = 1 . \tag{16}$$

In practice however, many other constraints can be imposed on the minimization condition. Even when assuming that all such other constraints exist, every value of λ will give a different efficient portfolio.

The concept of an efficient portfolio as discussed, relates strictly to financial criteria. In practice however, besides the risk-return criteria, there are a number of factors that limit the choice to a constrained set of efficient portfolios. Because of resource constraints, managerial criteria, laws and or regulations the investor may be limited to a set such as S' instead of S in Figure 3.

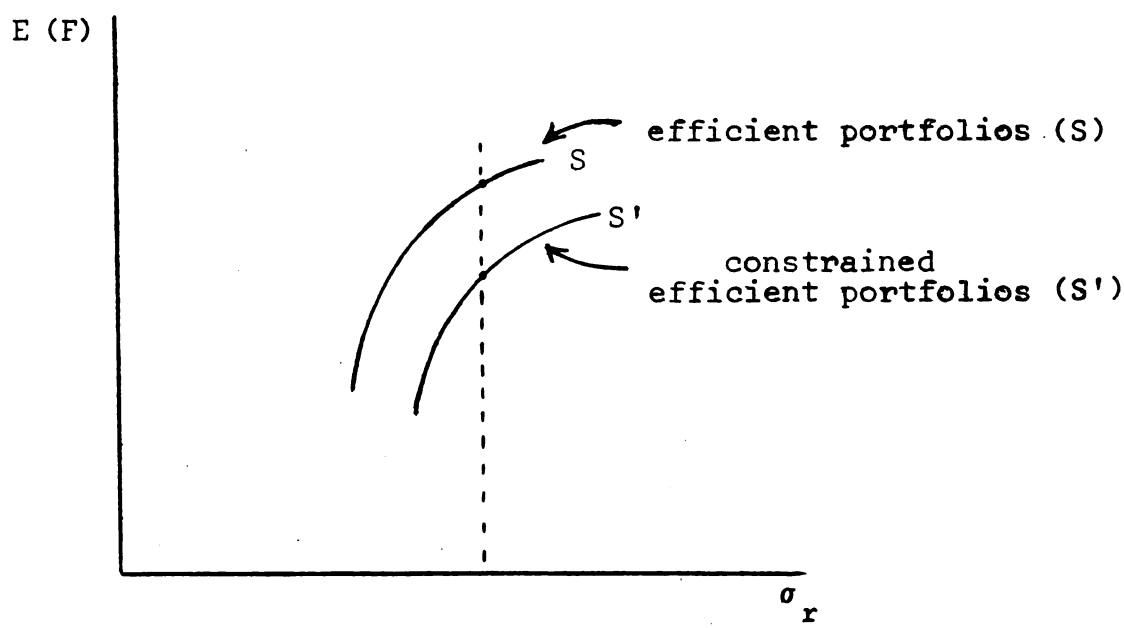

Figure 3. Efficient and Constrained Efficient Portfolios

In the case of S', for the same amount of risk the investor can obtain a smaller return because of the existence of other constraints. Incorporating these constraints in the selection of the efficient portfolios is straightforward as the model in equations (15) and (16) can be further constrained by:

$$\sum_i a_{ij} X_i \leq A_j \qquad (17)$$

where a_{ij} represent the resource requirement and A_j is a vector or resource constraints. Accounting for those constraints adds realism and practicality to portfolio models for individual or institutional investors who, besides a capital constraint, face a number of physical and institutional limitations.

Utility Maximization and Optimal Portfolios

Investors will choose from an infinite number of efficient portfolios, the combination that satisfies their own preferences. The later concept implies the existence of a utility function i.e., some relation between risk and return, the two decision elements in portfolio theory. The investor would, under such conditions, try to maximize his utility function. The latter reflects his attitude towards risk and return.

Because of the difficulty in estimating the nature of utility functions, much of the work on portfolio management has avoided this issue, although some economists have studied in detail the characteristics of particular utility functions and

considered several criteria for their evaluation. The concepts of utility go back to the 18th Century with the work of Bernoulli, who hypothesized that investors maximize expected utility or, in his own terminology, maximize "moral expectation".[4]

It has become common to assume that most investors are risk averse i.e., they dislike risk, hence they face a concave utility function. One can assume this concave utility function to be a negative exponential, lets say

$$U(Y) = 1 - e^{-a} Y, \text{ when } a > 0 \qquad (18)$$

Freund (1956) has shown that the expected value of a negative exponential, integrated over a normal probability density function can be expressed as:

$$E[U(Y)] = E(Y) - (\frac{a}{2}) \sigma_y \qquad (19)$$

In practice, the estimation of a utility function faces severe problems. In general terms, however, we can assume a expected utility function expressed as a linear relation of E(Y) and σ_y:

$$E(U(Y)) = E(Y) - \phi\sigma_y \qquad (20)$$

where ϕ is a constant risk aversion parameter. This development is due mainly to Tobin (1958), who explicitly distinguished between risk lovers and risk averters.[5] The first would be willing to trade a higher expected rate of return in exchange for a greater variance, while risk averters will only accept

more risk if they can expect "relatively higher" gains.

A solution to the investor's choice of an optimal portfolio can be found at the tangency point of the efficient set and the highest utility function. Obtaining such an optimal solution requires maximizing the objective function (utility) subject to a set of constraints. Quadratic programming can be used to obtain such an equilibrium solution, however linear programming also offers an alternative approach.[6]

The general maximization model that provides an optimal solution to this problem is

$$\text{Max } E(U) = E(Y) - \phi\sigma_y \tag{21}$$

$$\text{s.t.:} \quad \sum_i X_i \leq F \tag{22}$$

$$\sum_i a_{ij} X_i \leq A_j \tag{23}$$

$$X_i \geq 0 \tag{24}$$

In this case however, the model is formulated with the $X_{i's}$ being (absolute) amounts of money invested in each alternative and hence their total volume is not to exceed the available funds (F).

This general model can be applied to any financial institution and certainly to banks. The most important applications in the banking industry are reviewed next.

A Review of Bank Portfolio Models

The Static Models

The behavior of the banking firm has been studied and modeled with considerable interest during the last two decades. There are a number of models and approaches which are being forged together to form a theory of bank behavior. Although econometric, simulation and optimization models are available, the concern in this work is only with the latter.

It is possible to analyse the theory and models used to explain the bahavior of the banking firm in the context of their evolution with regard to particular issues. These issues are; first, the management of assets and liabilities; second, the incorporation of risk in the decision making process;and third, the simultaneous consideration of financial and real (physical) constraints in the determination of the firm's portfolio.

A large proportion of the literature on banking theory focusses on the analysis of partial static models of bank portfolio management. In these models the size of the portfolio is assumed to be exogenously determined, while the aspects of resource needs and constraints for the administration of the portfolio are ignored. These models focussed first on the issue of reserve and liquidity ratio management. Later on, with the influence of the work of Markowitz [1959], the aspects of risk and its effects on the composition of assets and liabilities were introduced. The issue of risk management however, becomes

more relevant in the complete models of bank portfolio management which are discussed later.

The basic models of reserve-liquidity management are based on the work of Edgeworth [1888]. The common feature of these models is that they treat the reserve-liability decision as a problem of inventory optimization under stochastic demand. It is assumed that on the asset side the bank can choose between, lets say, two types of assets: reserves (which could be securities) and loans. The bank would structure its portfolio trying to minimize the opportunity cost of excess holdings of the various assets.

In such a case, on the asset side, the problem is one of choosing the optimal allocation of the given funds among reserves and loans. This of course assumes that there is a minimum reserve requirement. The bank usually has the opportunity to hold a variety of assets and the choice among them is, as it will be discussed below, a function of relative risk and returns. In this regard, a priori selection of customers can be done if realistic knowledge about them is available. Therefore, it is hypothesized that the bank, by spending resources on the collection of information about its customers, can reduce the expected rate of default. Baltensperger [1972.a and 1972.b] linked the cost of incomplete information and the return to more information with the variability of certain random variables such as default loses and deposit fluctuations.

With regard to management of liabilities, Baltensperger [1980] indicates that the argument is usually made that the bank does not have a choice other than simply accepting all the deposits offered. The end of the year net interest earnings provides the bank with a new input in liabilities, known only in some probabilistic way. Managing this flow of earnings within the bank-capital account has also resulted in interesting contributions by Baltensperger [1972.a, 1972.b] and Taggart and Greenbaum [1978].

In summary, the static partial models of bank management deal with questions of asset choice or liability management. Their approach is comparable to the principles of minimum cost production given a level of output, according to the general microeconomic theory of the firm.

In the context of this research, it is more relevant to focus on more complete models of the banking firm, where the important issues are not limited to those of asset-liability balance, but also the influence of risk in management and the determination of the firm's size. These more complete models assume competitive behavior i.e., given interest rates. There is however, a number of models that incorporate monopolistic behavior in the banks' decision making and organization. The models developed by Klein [1971] and Monti [1972] assume that the bank has monopoly power and determine bank scale and portfolio structure via (net) revenue maximization.

These more complete models determine the optimal structure of assets and liabilities (apart from the exogenous capital account) as well as the total size of the bank, under the assumption that it acts as a price setter in the markets for bank loans as well as the markets for different types of deposits. This approach neglects resource constraints and it has been criticized for not providing a rational explanation of bank behavior [Baltensperger, 1980].

Some of these models have taken risk into account only in an indirect way. It is assumed that the firm cares about risk only to the extent that it is reflected in expected profit. The firm, therefore, does not directly consider risk in portfolio management in the sense of trading between expected return and variance of return. There are, however, a few models which approach the theory of the banking firm by applying the general theory of portfolio management under the assumption of risk averse behavior in the bank's administration. This approach, based on the works of Markowitz [1959, 1976], and Baumol [1963] treats the banking firm simply as a collection of financial assets with exogenous and stochastic rates of return and with liabilities treated as negative assets.

Within this later group of models, the simplest one is that developed by Pyle [1971]. This model is basically a decision tool for a financial intermediary which has the choice between three securities: a riskless security and two securities with an

uncertain yield over the given decision period, referred to as "loans" and "deposits". The later can, therefore, be held in negative amounts. The model is rather simple, ignoring liquidity and solvency considerations as well as resource costs and constraints. However, the interesting feature of the model is that the firm maximizes a concave utility function, i.e. it is risk averse.

Within the same framework, one finds the models proposed by Parkin [1970], and Hart and Jafee [1974]. Their models assume that the set of assets and liabilities which are held by the firm is institutionally given. This is a rather realistic assumption in light of segmentation in the money and capital markets [Van Horne, 1980]. Both models treat the institutional aspects as exogenous constraints on the admitted range of assets and liabilities. A similar approach to treat this aspect is the one used by Kane and Malkiel [1965], also under the consideration of risk averse behavior, where utility is maximized over a one calandar period.

In general, these models treat satisfactorily the aspects of risk management within the principles of portfolio theory in a static framework. However, a complete theory of the banking firm must explain how the firm combines its scarce resources of various kinds in order to satisfy objectives within the portfolio management approach. That is to say that the

optimal composition of the portfolio depends not only on the risk-return tradeoffs, but also it depends on the relative uses of the limited factors of production by each unit of the assets and liabilities. Within this framework, the literature on bank models is much limited; yet some valuable contributions have been made in the last years with regard to models that account for resource use.

The consideration of resource use in bank portfolio management was taken up first by Pesek [1970] with further refinements by Towey [1974], Adar, Agmon and Orgler, [1975], Sealey and Lindley [1977] and Saving [1977]. These models essentially represent pure production cost models of banking i.e., they explain size and structure of bank liabilities and assets purely in terms of the flows of real resource costs. All other aspects referred to before, including risk management are not considered. Even the latest of these models, proposed by Baltensperger [1980, p. 32-36] neglects specific account of risk management.

A known exception that incorporated risk averse behavior and accounted for constraints in the decision making, but in a static framework, is the work of Robison [1975] which is summarized in Robison and Barry [1977]. Robison developed a quadratic programming model and used it to evaluate how an expected utility maximizing choice is changed in response to factors shifting the mean-variance (E-V) efficient set and changes in

the decision maker's level of risk aversion. The author also reports consistency between bank behavior and the E-V decision criteria. The model was used to evaluate alternative agricultural finance policies on their effect on a commercial bank portfolio.

As noticed, the proceeding discussion focussed on bank portfolio models within a static framework of analysis. Although all this work provides interesting contributions to the field of modelling bank behavior, it totally neglects the issue of "dynamics" in modelling bank portfolios.

The Dynamic Models

There have been two alternative approaches to model bank behavior in a dynamic framework: simulation models and optimization models. While the first are useful to find out the effects of alternative decisions, they are of limited applicability in trying to determine what is the "best plan" for the bank in terms of the combination of its resources to attain specific objectives and goals over time. With this latter purpose in mind, optimization models offer the best alternative approach. They build on the principles of portfolio theory and some interesting applications have been made in the last twenty years.

The dynamic models of bank portfolio are perhaps some of the most interesting contributions in dynamic portfolio management.

Given the operating procedures of banks, these models are more complete and useful than static models. In reviewing these models two groups can be identified. The first does not account for risk in the objective function, hence they are basically dynamic optimization models, with risk management policies built in the model constraints. These models are in the majority. The second are models that explicitly include risk in the objective function; hence the dynamic sheet balance optimization accounts for trade offs between expected returns and variance-covariance of returns among the alternatives for the sources and uses of funds. Because of the complexities of treating risk in the dynamic decision making process of bank management, this latter category of models is known only on a theoretical basis.

The first known dynamic model is the one proposed by Chambers and Charnes twenty years ago. Their model finds the balanced asset portfolio which maximizes returns over a planning horizon, while meeting various constraints in each period. The "balanced" portfolio is the one that meets the regulations of the bank examiners of the Federal Reserve System. It is assumed that the banker knows the level that will prevail, at various dates in the future, of demand and time deposits, of rates of interest and the bank's net worth. The objective is to maximize profit and the investment choice is among loans, government securities and bonds, each with alternative maturities.

Chambers and Charnes' model accounts for risk only indirectly through leverage requirements as a function of the assets' liquidity.[7] Their major contribution can be found in the interpretation of the dual to the LP problem. This allows to measure the marginal rate of return on additional available capital at any time period, the opportunity cost of reserve requirements and the benefits of rediscounting and lending out.

As Cohen and Hammer [1966, p.89] have commented, the fact that the Chambers and Charnes approach employs a multiperiod model should not be missinterpreted to imply that the plans formulated for the entire horizon should be inviolable. The main purpose of the model is to help determine what actions should be taken at present (i.e., in the first time period). More than one period is hence included to avoid the suboptimal decisions which might result from a shortsighted view that ignores relevant aspects of the future. Still, the choice of the length of the planning horizon is a difficult task, usually depending on the stability of the environment and the length of calendar time represented in each time period in the model.[8]

A further refinement of the original model was offered by Cohen and Hammer [1967], including three alternative objective functions: (1) maximize the value of stock holder equity at the end of the final period; (2) maximize the present value of the net income stream over the planning period or finally; (3) maximize the present value of the income stream during the

planning period, plus the stockholder equity at the end. The authors preferred this later function. In addition their model takes into account operational constraints as well as projections of various intertemporal relationships between stocks and flows of deposits, reserves and loan demand.

Cohen and Thore [1970] extended the model by Cohen and Hammer to include information contained in discrete probability functions that attach to levels of liabilities and interest rates. The problem then, became one of two-stage programming under uncertainty. In the first stage, the interest rates are determined for future time periods and in the second stage, they are taken into account in making current decisions. Further developments of the two-stage programming model were proposed by Crane [1971]. Crane's model maximized the expected rate of return, using two-stage programming under uncertainty subject to some multiperiod inventory constraints, to assure that purchases did not exceed net cash flows plus sales. Although Crane's model did not include risk in the objective function, it included a constraint to limit the maximum capital loss. Because the model included very few constraints, the results of the model were unrealistic since only one or two assets were considered.[9]

The models reviewed above were basically normative. Their intent was to produce solutions that reflected optimal conditions and hence suggest changes in the current portfolio moving towards optimality. However, the lack of realism of those models could

have provided "optimal" solutions that were impractical, institutionally infeasible or politically unacceptable.

Other dynamic portfolio models have been designed with the purpose of explaining the current portfolio and its adjustment process. By removing the current constraints or by changing specific parameters one could asses the effects on the portfolio structure and its new adjustment path. This can be described as a choice and adjustment process. It is a choice in the sense that the model selects an optimal equilibrium portfolio while an adjustment would involve the speed and method of moving towards some new equilibrium.

Among these models the first one is the purely theoretical case proposed by Porter [1961]. The model included risk explicitly, in the objective function, as this was the maximization of utility and not just the maximization of profit. Other models were developed within this line of work, such as those of Fried [1971], Hester and Pierce [1975], Frey [1977] and Beazer [1975].

Explicit account of risk in a dynamic model's objective function is cumbersome and the issue has been avoided. If the model was to maximize a multiperiod utility function it would be possible to write.

$$U = \sum_{t=0}^{T} E(\pi)_t - \phi \sum_{t=1}^{T} V(\pi)_t \qquad (25)$$

where, assuming that activities can be designated by X_i, then,

$$\sum_{t=0}^{T} (\pi)_t = \sum_{t=0}^{T} \sum_{i=1}^{I} v_{it} X_i \lambda^t \qquad (26)$$

where v_{it} is the return and λ_t is the appropriate discount factor for a given price of capital (ζ),

$$\lambda_t = \frac{1}{(1 + \zeta)^t} \qquad (27)$$

The variance of present value however is calculated as a function of the variances of each period's present value of cash flows on the net available funds [see Anderson, Dillon and Hardaker, 1977, p. 260]. To do this it is necessary to take account of the covariance between the cash flows of different time periods. The relationship is

$$V(\pi) = \sum_{t=0}^{T} V[(\pi)_t] + 2 \sum_{t'=0}^{T-1} \sum_{t'=t-1}^{T} \operatorname{cov}[(\pi)_{t'}, (\pi)_t] \qquad (28)$$

$$V(\pi) = \sum_{t=0}^{T} V[(\pi)_t] + 2 \sum_{t'=0}^{T-1} \sum_{t=t'-1}^{T} \rho_{t',t}\, \sigma(\pi)_{t'}\, \sigma(\pi)_t \qquad (28.a)$$

The covariance term is of particular relevance in this case as funds available in period t are a function of funds available in all previous periods. Similarly the risk in fund availability in period t is related to the risk in previous periods.

As the incorporation of this covariance effect would add significant complexities to the model, alternative more simple

approaches have been used. Fried [1977] utilizes chance-constrained programming to accommodate the Markowitz formulation to stochastic movements in deposit levels and returns and to provide trade-offs between risk and return. The model maximizes expected return subject to probabilistic constraints on acceptable levels or risk and illiquidity. The risk constraint is formulated as:

$$E - k\sigma \leq \epsilon \qquad (29)$$

where E is the expected return on the portfolio, σ is the standard deviation, k is a number of standard deviations, and ϵ is a safety level or lower limit that the expected return must exceed with certain probability. The solutions were compared with the actual portfolios chosen by the banks and the author concluded that the actual bank portfolios were inefficient, since they had rates of return lower than the ones selected by the model. This assertion however, assumes that the model formulation actually represented the bank's real objective and all constraints; which could have not been the case,as institutional and resource constraints were not included.

Hester and Pierce [1975] developed a multiperiod LP model to address the issues of growth, size and market imperfections created by public policy and unforseen events. Although the choice issue in bank portfolio models is very important, Hester and Pierce [1975] emphasized more the adjustment process as a result of changes in policies. They developed a dynamic model

that allowed to determine that the length of time for the adjustment process to be completed, was approximately eight weeks for cash inflows and eight months for mortgages. Their analysis of the adjustment of bank portfolios was of particular relevance for the lagged effects of monetary policy. The authors concluded that costs of adjustments to external shocks and variations in interest rates are very important in accounting for variations in bank portfolios and profits.

One of the most complete dynamic bank portfolio models is the one developed by Beazer [1975]. The aim of this work was to compare the portfolio chosen by the model with the one actually chosen by the bank. The author insisted that the bank's criteria is not profit maximization but utility maximization; the bank's objective and choice function involved not only a trade off between risk and return but also included liquidity considerations. It maximized the rate of return of the portfolio but warned that such an objective may not lead to the same results as maximizing the present value of the expected earnings stream. However, this was operationally more simple and "probably more closely approximated what (bank) portfolio managers actually use as criterion function" [Beazer, 1975;p. 23]. The model was first described as a portfolio model in which the choice set was defined by the trade offs between risk and return. But the risk measures in the model were not in the objective function but in the form of liquidity constraints. In this sense it was an unconstrained feasible set. However, because of

the capital adequacy ratio, required reserves and other constraints, the choice set was reduced to a constrained feasible set.

In spite of the significant contribution of Beazer's model, it was still a financial management model which did not take into account physical constraints. It was assumed that if a portfolio was financially sound, then the bank will adjust its physical needs accordingly. Although a valid assumption in large commercial profit oriented banks, it is questionable in the formulation of short term policies among small commercial banks and among development banks which may have severe limitations for immediate adjustment in physical resource needs. Hence, in the later case such constraints must be considered, therefore, defining an even narrower feasible set.

Concluding Comments

This review is indicative of abundant research on bank portfolio models. Yet, the work is a disseminated set of bits and pieces that have not been linked together in a generalized theory of bank portfolio management. Furthermore, all the work is within the area of commercial banking in developed countries. However, in developing countries, political constraints, risk and (more) imperfect capital markets add complexities to the management of the bank portfolios. Nevertheless, the existing models provide valuable insights that can be adapted to the special case of agricultural development banks.

The Building Blocks of an ADB Model

Building a portfolio model for a specialized agricultural development bank has the purpose of evaluating the current practices and restrictions and exploring alternative means for a more rapid and stable bank growth.

From Chapter II it is clear that specialized agricultural development banks operate in an environment where institutional design and policy limit the sources and uses of funds. Also, sociopolitical factors impose additional constraints that affect the financial performance of the institution.

From the previous sections in this chapter it can be inferred that while a number of commercial bank portfolio models have been built with the purpose of addressing specific issues, none of these models provides a quantitative framework for agricultural development bank portfolio management. Also, there are not portfolio models for development banks. However, by building on several aspects provided by earlier commercial bank models, it is possible to build a portfolio management model for an agricultural development bank.

The model proposed here builds on earlier efforts, and hence, it resembles the treatment of assets and liabilities in the pioneering work of Chambers and Charnes [1961] and Beazer [1975]; it treats discounted flows of money as suggested by Cohen and Hammer [1967]; it takes into account resource constraints as suggested

by Baltensperger (1980) and builds on the dynamic framework used by Fried (1970). Further refinements are introduced, including disagregation of the loan portfolio for different crops and livestock; constraints that reflect development bank goals; a measure of risk that enters directly the bank's objective funtion; and a general formulation that allows for the simulation of alternative relevant policies. These policies include credit insurance, alternative interest rates, changing the clientele, and ultimately modifying the bank's physical and institutional constraints. Furthermore, the formulation allows, with relatively few changes, a transformation of the model for a specialized bank into one with multiple functions including those of handling savings and checking accounts and other liabilities.

To model the bank's decision making framework and to accommodate the needs of the analysis, a multiperiod linear programming model has been chosen as the appropriate quantitative tool. The mathematical programming model is structured with three basic components: i) A set of alternatives which in this case are the various sources and uses of funds or, in the context of the bank's balance sheet, the assets and liabilties. ii) A set of restrictions (constraints) which include the availability of resources, the financial and operating constraints, and the institutional (political) restrictions. iii) An objective (the objective function) to be optimized, which in this case is multiperiod utility to be maximized.

As it will be discussed later, the objective is utility in a multiperiod horizon, hence the model includes a measure of risk. Also, several constraints and activities are needed to allow for intertemporal transfer of funds. The alternative sources and uses of funds, the institutional and physical resource constraints and the financial constraints are discussed in the following sections.

Alternative Sources and Uses of Funds

There is no reason why a development bank could not fulfill the functions of a financial intermediary. In such a case, on the liability side the bank could accept time and demand deposits, borrow from the Central Bank and from other national or international banks, and hold equity. In the asset side the bank could issue different types of loans and mortgages and invest in alternative securities.

The general model is developed for a development bank which can fulfill all the functions of a financial intermediary, but the application in the next chapter is to the case of a specialized bank. Therefore, on the asset side (the uses of funds) the alternatives are the issuance of loans, the acquisition of investments and the holdings of cash.

The loans can be classified in terms of their use for annual crop production, establishment of orchards, herd build-up, cattle fattening, farm equipment and machinery and farm improvements.

Loans for annual crop production and cattle fattening are of less than one year of maturity. The other loans have maturity periods between 2 and 5 years. Annual crop production loans usually represent at least 50 percent of the number of loans issued however, in terms of value, they may account for only 30 to 40 percent of the loan portfolio. Because of the clientele the bank serves, loans should be properly disagregated by sizes. This is necessary because the bank usually imposes requirements of serving a large number of small farmers with the consequent high costs that such practice imposes. Another criteria on the disagregation of loan categories is whether they are insured or not. As it has been discussed before, insured loans provide higher average returns to the banks. Yet there are restrictions on their number and volume because of the capacity of the agricultural insurers and/or because certain loans do not meet the insurer's selection criteria. If we define the principal of a loan as L, then we can distinguish the following categories:

$$L_{ijkm}$$

where:

i = purpose[10] (i= 1 --- I)

j = 1 if insured, zero otherwise

k = size (k= 1 --- K)

m = maturity (m= 1 --- M).

The other investments or options to the bank include government and agency securities of various maturities and stocks.

The legislation in each country may inhibit the bank from investing in particular types of securities. Cash and reserve holdings are usually a proportion of the bank's total assets and in any event they are not part of the allocation of funds problem.

In summary the bank's choice of assets include:

L_{ijkm} , loans

G_m , government securities

O_m , other securities

C , cash .

This code refers to the nominal value of each asset except for cash, hence the decisions concern the number of each type of asset to acquire. The purchase of securities in this case is restricted to maturities in annual intervals. Shorter term maturities may be preferable to take advantage of cyclical availability of funds influenced by the seasonal demand for loans. Yet this can not be handled with an annual time structure of the model. It is also assumed that securities can be redeemed only at maturity.

The liability options for a development bank are, as for most banks, demand deposits, time deposits, borrowings from the Central Bank, from commercial domestic banks, from commercial international banks and from international development agencies. Agricultural development banks also receive significant amounts of government subsidies. ADBs rest primarily on this last source in the form of allocations from the Central Banks (or from the treasury) which obey macroeconomic policy and

agricultural development strategies. Although, this source of funds has been the primary one for most development banks, its future continuous supply is jeopardized by the difficult financial situation of most developing countries. Paradoxically, the banks have obtained larger amounts of these resources when their performance has been worst. Such allocations have been provided to allow the banks to continue in operation, and fulfill their "development" role in spite of their financial performance.

Demand and time deposits have not been a primary source of funds of ADBs, yet the diversification of the banks to take advantage of these opportunities is largely advocated. The issuance of savings accounts demands the offering of a competitive rate. It is assumed that at such rate the bank would attract deposits as to optimize its portfolio, and hence an unlimited amount of potential customers.

Borrowings from commercial banks (domestic and foreign) is also practiced at competitive rates, therefore this activity requires government subsidies. There is in addition a complexity that arises because of foreign exchange risk on funds borrowed in the international market. This, however, is not considered here.

Borrowing from international agencies at low interest and other easy conditions has been a major source of funds, particularly during the last 2 decades. That, however, has taken the

countries into severe indebtedness. As a result, it is not likely that the rate of growth of such funds could be maintained, unless the banks show a higher ability to administer such funds. Alternatively, the development banks would borrow more significant amounts from commercial banks.

In summary the choice of liabilities include:

DD, demand deposits (number of accounts of different size)
TD, time deposits (number of accounts of different size)
BC, borrowings from commercial banks
BI, borrowing from international development financial agencies
GS, government subsidies.

Purposely this section has begun with a description of the bank's alternatives, to provide the basis for the following discussion of how the bank could choose from among those alternatives, within the limits of its operating constraints.

Institutional and Resource Constraints

The bank's authorities, following the principles of portfolio theory, could choose from among efficient asset and liability portfolios contained in a unconstrained set of feasible financial solutions. Yet, in reality the choice is limited to a more restricted set, because of the existence of institutional and physical constraints.

The institutional constraints are those that are established

to fulfill governmental policy and those that obey current bank organization. The spatial allocation of funds is in many cases an important institutional constraint. Others refer to the balance of small and large loans that must exist in the portfolio and the assignment of volumes of credit for particular crops.

If restrictions existed on minimum amount of funds to be allocated to particular crops or livestock, this constraint can be specified as:

$$\sum_i \sum_j \sum_k \sum_m N^t_{ijkm} \; L^t_{ijkm} \geq L^{t*}_i \qquad (30)$$

where:

N^t_{ijkm} is the number of loans of type ijkm issued at time t.

L^t_{ijkm} is the principal of loan of type ijkm.

L^{t*}_i is the minimum amount of funds that must be assigned to purpose i in year t.

This is a particular situation for export crops that provide the basis for the country's foreign exchange earnings or food grains to provide basic food supplies. These constraints could alternatively be formulated in terms of required volumes of production and let the bank allocate the funds in the most optimal financial way.

Another important constraint may be defined by the value of insured loans that can be issued every year. In addition, there could also be restrictions on insurance to be provided for only

certain crops and regions. The above constraints are not defined by the bank authorities, but by the insurance agency, according to financial and resource availability constraints, geographic coverage or particular rules and regulations that exclude certain bank loans from the insurable set of loans. If, out of the total loans issued by the bank, we can define a set of insurable loans, then the constraint can be specified as:

$$\sum_i \sum_j \sum_k \sum_m N^t_{ijkm} \, L^t_{ijkm} \leq L^{t*}_{j=1} \qquad (31)$$

where $L^{t*}_{j=1}$ is the maximum value of insured loans.

There may also be requirements that the bank guarantees the supply of credit to the smallest farmers or an explicit decision to exclude certain group. In this case specific constraints may be imposed on loan size, lets say:

$$\sum_i \sum_j \sum_m \sum N^t_{ijkm} \, L^t_{ijkm} \geq L^{t*}_{k=1} \quad \text{or} \qquad (32.a)$$

$$\sum_i \sum_j \sum_k \sum_m N^t_{ijkm} \, L^t_{ijkm} \leq L^{t**}_{k=3} . \qquad (32.b)$$

The most severe institutional constraint under which agricultural development banks operate is the low nominal interest rate. Modeling this constraint does not require a specific equation, since it is imbeded in the definition of the loans, i.e., in the column vectors of the model. Changing this parameter is an important policy consideration and some time is devoted to it in the empirical analysis undertaken in the following chapters.

An important set of constraints in the model are the physical resource constraints that, in the short run, define the bank's operating capacity. These constraints have been omitted from most bank portfolio models, under the assumption that, if a financial decision proves rewarding, the institution will immediately adjust its resource base. In developing economies and particularly in public institutions, such adjustment is almost impossible to make in the short run. In the particular case of the ADBs, they have a limited number of loan officers, office capacity and equipment and vehicles for field supervision. On the other hand, previous research and bank officers' opinions support the hypothesis that loan supervision improves loan recovery rates. However, with current resources, ADBs are operating under severe pressure to administer many more loans than they should.

The specification of these constraints deserves further discussion. The situation can be modeled defining current loan requirements of vehicles and personnel (the stronger constraints) and current resource availabilities. Such relationships automatically define the current loan recovery rates. The constraints can be specified as follows:[11]

$$\text{personnel} \quad \sum_i \sum_j \sum_k \sum_m a^t_{ijkm} N^t_{ijkm} \leq A^t \qquad (33)$$

$$\text{vehicles} \quad \sum_i \sum_j \sum_k \sum_m b^t_{ijkm} N^t_{ijkm} \leq B^t \qquad (34)$$

where a_{ijkm} and b_{ijkm} stand for the personnel and vehicles requirements for the administration of each loan; and A^t and B^t are the

resource supplies.

The set of loans could in this case be divided into loans with alternative levels of increasing supervision (w), let's say a_i^1; $a_i^2 \ldots a_i^w$; b_i^1, $b_i^2 \ldots b_i^w$, with their corresponding higher recovery rates. Specifying the above would imply knowing a functional relation between loan supervision and recovery rates. Hence, if the a_i^w and b_i^w are points of a linear relation of recovery rates and loan supervision, the constraints can be specified as:

$$\sum_w \sum_i a_{ijkm}^{wt} N_{ijkm}^{wt} \leq A^t \qquad (35)$$

$$\sum_w \sum_i b_{ijkm}^{wt} N_{ijkm}^{wt} \leq B^t . \qquad (36)$$

Enlarging the availability of resources would have the following two effects: First, it would increase the total number of loans that can be issued and second, it would increase the number of more supervision-intensive (more rewarding) loans.

The physical constraints defined above are the most important ones. The list can be expanded for particular situations without difficulty.

Financial Constraints

As any financial institution, but with certain peculiarities, ADBs face a series of financial constraints. The Capital Adequacy Ratio is perhaps one of the more stringent constraints in bank portfolios and it is intended to preserve the banks as a

viable entity through periods of financial distress. Leverage requirements are, therefore, demanded by Central Bank Authorities, as a balance between assets and liabilities, depending on the liquidity characteristics of each component of the portfolio. It is not known whether development banks are or not exposed to penalties for not meeting these requirements, nevertheless good banking practices would demand them.

Dealing with assets, Chambers and Charnes [1961] and Beazer [1975] suggest following the criteria of the Examiners of the U.S. Federal Reserve Board. Such criteria distinguishes four categories of assets, each with a given illiquidity index (δ):

Category	Assets	δ
Primary and secondary reserve	Reserves and cash in vault and government securities maturing in less than 2 years	0.005
Minimum risk assets	Government securities maturing in more than 2 years and less than 10 years and insured loans	0.040
Intermediate assets	Other securities and government securities of more than 10 years	0.060
Portfolio assets	loans	0.100

It is possible on this basis to define a weighted index of illiquidity of bank assets (A).

$$A = \sum_{i}^{I} \delta_i A_i \qquad (37)$$

or more specifically:

$$A = 0.005\ C + 0.040 \sum_i G_i + 0.060 \sum_i O_i + 0.100 \sum_i L_i \quad (38)$$

where all variables could be of different types:

C = cash

G_i = government security of type i

O_i = other securities of type i

L_i = loans of type i.

On the liability side, the liquidity charecteristics of the various sources of funds have also been defined by the Examiners criteria.

Liability	η_i
Demand deposits	0.47
Time deposits	0.36
Other deposits, borrowings, from Central Bank and from other banks	1.00

Therefore one can also define a weighted index of liability liquidity (D):

$$D = 0.47\ DD + 0.36\ TD + 1.00\ (BC + BI + GS) \quad (39)$$

where all terms have been already defined.

On this basis, the leverage requirements can be expressed as:

$$A \leq W - D \quad (40)$$

where W is capital or net worth. Since each component of A and D

is endogenous, we can express the leverage requirements as:

$$A + D \leqslant W. \qquad (41)$$

This constraint would encourage the bank to hold more liquid assets and less liquid liabilities. As it shifts more illiquid to liquid assets, the index A is reduced for a given level of total assets and as it shifts into less liquid liabilities, the index D is reduced for a given level of total liabilities. In either case, it becomes possible to increase total assets and total liabilities relative to net worth.

The banks are also recommended to hold a minimum amount of money determined as 15 percent of the first $100,000 of the portfolio, plus 10 percent of the next $100,000 plus 5 percent of the next $300,000. In the case for example of a bank with 500,000 in assets, the capital-adequacy ratio would be written as:

$$A + D \leqslant W + 40{,}000.^{12} \qquad (42)$$

The most important determinant of bank growth, is its returns from the activities of the previous period. As it was discussed in Chapter II, the volume of loans and purchases of other assets in period t, depends on the collections minus costs (the net surplus of funds) in period (t-1), plus any authorized disbursements from borrowings from other banks, central government allowances, disbursable (net of reserves) time and demand deposits and operating and financial costs:

$$\sum_i \sum_j \sum_k \sum_m N^t_{ijkm} L^t_{ijkm} + \sum_i M^t_i Y^t_i + C^t + (R_k B_k)^t + (OE)^t$$

issued loans + purchases of securities + cash + amortization of borrowed funds + operating expenses

$$\leq [\Sigma N^{t-j,t}_{ijkm} L_{ijkm} (1 + r_{ijkm}) \gamma_{ijkm}] + \Sigma M^{t-j}_i Y^{t-j}_i (1 + y_i)$$

(loan collections: principal and interests) + maturing securities

$$+ (BC)^t + (BI)^t + (GS)^t + (TD)^t + (DD)^t$$

+ borrowings from commercial banks + borrowings from IFAs + government subsidies + time deposits (net) + demand deposits (net)

(43)

Another important constraint on agricultural development bank refers to the usual decision on maximum allocation of funds to each regional office in each time period. This is done to allow each regional office to meet its credit obligations regardless of its performance in the previous period. Hence, this constraint guarantees that poorly performing offices can continue in operation, while at the same time it deprives the best performing offices from having a faster growth. Once again in this case, the bank policy is to redistribute the benefits of credit among groups, benefiting those that because of "whatever reasons" were unable to pay their loans on time. Ultimately, such policy has resulted in severe indebtedness of poorly performing farmers who were given credit beyond their repayment capacity, while at

the same time it has served to subsidize farmers that were unwilling to pay back their loans. This model does not include spatial disaggregation, hence this constraint is not included.

These constraints are the most important factors determinant of resource allocation by the ADB, according to specific allocative criteria. The following section takes up the issue of modelling the bank's objective to allocate financial resources among alternative uses over time, within the limits of existing constraints.

The Multiperiod Model

The Bank's Objective

As it was discussed in Chapter II an ADB has many goals to meet. These have been incorporated through constraints that demand credit for particular groups of producers and crops, plus the condition of low interest rates. However, as it also was discussed in Chapter II, the banks must operate under some behavioral rule, and utility maximization has been chosen as this criterion.

The bank allocative criteria is necessarily based on dynamic cash balance relations. At each time period the allocation of funds is limited by the availability of resources and the risk and maturity preferences among the feasible choices of assets and liabilities. This determines that the bank maximizes a multiperiod financial objective, but meeting annual goals.

As for the objective of the bank, no generalization can be made as to what is the common rule in a dynamic decision process. There are a number of possible maximizable objectives, like net worth of the bank, total cash flow, discounted present value of cash flow, average earnings over some period, growth rate of earnings, utility measured over a period of time, etc. Although there are many possibilities, two have been used in most cases: a) maximize the net worth of the bank at the end of planning horizon and b) maximize the present value of the stream of cash flows generated during the planning horizon, plus some adjustment for increased net worth of the bank.

Bradley and Crane (1975) argue in favor of the first objective function because, they say, if all investment opportunities have been included in the model, it can be considered as a closed economy, completely describing the bank's earning opportunities. However, as the opportunity cost of money over time should be considered, particularly under inflation, a discount function may be preferred.[13]

An important determinant of bank growth relates to the availability of funds from previous periods. The most important constraint exists on loan issuance and purchase of securities in any time period. These can not exceed the sum of proceeds from loans and securities maturing on that date, the increase in the bank net worth since the previous date and the disposable net deposits and borrowings.

Given the above, we can assume that the bank maximizes a discounted objective function, like equation (4) that now can be written as:

$$U = \sum_t \left[\frac{(NR)^t}{(1+\zeta)^t}\right] + \frac{TW_T}{(1+\zeta)^T} - \phi \sum_t \frac{\sigma_t}{(1+\zeta)^t} \qquad (44)$$

where $(NR)^t$ is net return, TW_T is terminal wealth at the end of the planning horizon, and everything else is already defined.

Notice that in the decision-making process what is important is to know the optimal decisions in the first period since these are the only ones that can be implemented. However, these "optimal first period decisions" must be interpreted carefully as the first step in a plan that is optimal in a long run sense. Later time periods are introduced because we do not know how to modify the criterion function to reflect the consequences of present decisions on future opportunities and because of intertemporal linkages.

In the context of multiperiod planning two points deserve further attention: i) the choice of the discount rate, and ii) the length of the planning horizon. There is not complete agreement on these issues, hence the available alternatives are reviewed before proposing one:

i) Some of the plausible alternatives for the proper discount rate are: a) the bank's cost of capital; b) the rate at which the stock market implicitly capitalizes net income in determining the market value of the bank's stock and; c) the

bank's own and subjective time rate of preference for net income. Most economists would agree that, on a theoretical basis, the bank's cost of capital should be used. Furthermore, the nature of ADBs as public institutions provides a supporting argument for this criterion. To test the relative importance of this parameter, the model should be solved for different values of the discount rate.

It must be recalled that a time preference criteria is included because we recognize that there is the choice between savings and consumption in the Fisherian sense. Therefore, the model would allocate resources between end of period stockholder income and reinvestment. Since ADBs can in principle be public or private, the distribution of earnings at the end of each period will make sense only in the later case.

ii) Much discussion has also been offered in regard to the length of the planning period in a multiperiod LP model. The value of T in a T-period model should be chosen, such that the set of first period decisions becomes insensitive to further increases in T. More complex criteria are offered for the cases of replacement problem models, such as those applied for livestock and tree crop planning models [see Boussard, 1971; Weintgardner, 1962; Miller, 1979; and Gunter and Bender, 1980].

The above criteria gets complete validity when the model's objective function includes the terminal value of wealth. In such case one can obtain, with only T period solutions, the

same first period decisions that would be made if returns were discounted over a much larger horizon. It should be mentioned however, that an important criterion in deciding for an initial length of planning period is the maturity of the bank's assets and liabilities. If the bank issues livestock loans that mature within a 10 year period and that is the longest maturity, then that is the minimum length of planning period if livestock loans were issued only in the first period. This model will, therefore, use as a criteria for choosing T the "no change in the first period solution when another period is added".

Incorporating Risk Measures in the Multiperiod Model

The particular nature of agricultural banking implies that loans are a risky activity. The riskiness of bank earnings on loans is measured by the recovery rate. This reflects the forgone earnings because of late repayment or no repayment at all. At a particular point in time (s) the bank expects to recover $L_{is} + r_{is}$ (see Chapter II) but it collects only $(L_{is} + r_{is})\gamma_{is}$. Hence the lower the value of γ_{is}, the smallest the net return to the bank.

From previous experience the bank can estimate the expected recovery $E(L_i + r_i)$ as:

$$E(L_i + r_i) = \sum_{s=1}^{S} \gamma_{is}(L_{is} + r_{is})/S \qquad (45)$$

where γ_{is} is a random variable and (s=1...S) is the length of time periods for which the information is available. Similarly the variance of return can be expressed as:

$$V(L_i + r_i) = \frac{\sum_{s=1}^{S} [(L_{is} + r_{is}) - E(L_i + r_i)]^2}{S-1} \qquad (46)$$

Incorporating measures of risk in static mathematical programming models has followed alternative approaches. Because most of the work has used the E-V (Markowitz) approach, there has been heavy reliance on quadratic programming models. But also because of the computational difficulty with QP, alternative methods have been developed to approximate QP solutions by means of linear programming. Some of these include the mean of total absolute deviations (MOTAD) as proposed by Hazell [1971]; separable programming, suggested by Thomas, et al [1972], which approximates the non-linear total variance constraint by piece-wise linear functions; and the marginal risk constraint LP, first suggested by Chen and Baker [1974], which consist of a complex multi-stage procedure.

Another approach with a limited applicability is the one proposed by McCarl and Tice [1980] which diagonalizes the variance-covariance matrix of returns by applying the principal axis theorem. The advantage of this approach is that it reduces computational complexities in applying separable programming by decreasing the number of piece-wise linear approximations; however, it is limited to the cases where the variance-covariance matrix is positive (or negative) definite. More recently, Kim and Yanagida [1981] developed Direction Constraint Linear Programming (DC-LP), which also approximated the variance boundary constraint.

MOTAD has been the most widely used technique for incorporating risk measures into LP models. It is simple and particularly attractive in large models that would be too expensive to solve in a QP format. Using MOTAD, with the advantages of a linear programming formulation is not without its problems. When the population of expected returns for each activity is approximately normally distributed and when estimates of the variance and the mean absolute deviation are used solely on sample data, though both estimated Standard Deviation and Mean Absolute Deviations (m.a.d.) are unbiased, the relative efficiencies of the two estimators may differ. Hazell [1971] had pointed out that the sample m.a.d. is only 88 percent as efficient as the standard deviation in estimating the population standard deviation.

Using the MOTAD approach demands that the variance of the loan portfolio, defined in equation (46) can be replaced by:

$$V = \sum_{i}\sum_{s} L_i \; L_{i'} \left[\frac{1}{s-1} \; (r_{si} - \bar{r}_i) \; (r_{si'} - \bar{r}_{i'})\right] \qquad (47)$$

where:

s, is the number of periods for which sample observations are available (s = 1,2,...S)

r_{si}, is the return to the i^{th} loan in period s. Notice that i' is used to denote any other loan.

$\bar{r}_i$, is the mean return for the i^{th} loan, which is defined

$$\bar{r}_i = \frac{\sum_{s} r_{si}}{S} \qquad (48)$$

Summing up over s in equation (47) and factoring:

$$V = \frac{1}{S-1} \sum_{s=1}^{S} \left[\sum_{i=1}^{n} r_{si} L_i - \sum_{i=1}^{n} \bar{r}_i L_i \right]^2 \qquad (49)$$

where $\sum_{i=1}^{n} r_{si} L_i$, is the total gross return of a particular loan portfolio.

Assuming that the same sample data are available as for equation (49), the M.A.D. (denoted by Γ), may be defined as:

$$\Gamma = \frac{1}{S} \sum_{s=1}^{S} \left| \sum_{i=1}^{n} (r_{si} - \bar{r}_i) L_i \right| \qquad (50)$$

which is an unbiased estimator of the population m.a.d. Hence, the (E,V) model can be replaced as the (E,Γ) model. The advantage of the E, Γ model is that it leads to an LP formulation of the portfolio selection problem. When returns exhibit a trend, the deviations can be measured from the regression line of returns over time as shown by Hazell and Pomareda [1981].

To approximate Γ as an estimator of the standard deviation, it is possible to write:

$$\tilde{\sigma}_i = \frac{\Delta^{\frac{1}{2}}}{S} \sum_{s=1}^{S} (r_{si} - \bar{r}_i) L_i \qquad (51)$$

where $\Delta^{\frac{1}{2}}$ is a correction factor to convert the mean absolute deviation to an estimate of the population standard deviation, as proposed by Hazell and Scandizzo [1974] and used first by Simmons and Pomareda [1975].[14] This formulation can be entered in the model by defining new variables $Z_s \geq 0$, and forming the problem:

$$\max U = \sum_{i=1} E(r_i) - \phi\tilde{\sigma} \qquad (52)$$

subject to:

$$\Sigma(r_{si} - \bar{r}_i) L_i + Z_s \geq 0, \; s = 1,..,S \qquad (53)$$

and

$$\sum_{s=1}^{S} Z_s - \tilde{\sigma} \frac{S}{2\Delta^2} = 0 \qquad (54)$$

The Z_s variables measure the negative deviations of returns from the mean; therefore $2 \sum_s Z_s$ is the sum of total deviations. In matrix form, for a one year period, the problem can be formulated as in Figure 4.

This formulation is in general applicable in a static model. However, as it was discussed earlier, the multiperiod objective function of the bank [equation (44)] implies a measure of covariance of returns between time periods. We should recall that the LP model uses an estimate of the standard deviation, Therefore, assuming only two time periods, equation 28.a can be written as.

$$V(\pi) = V(\tilde{\pi})_1 + V(\pi)_2 + 2\rho_{1,2}\sigma(\pi)_1 \sigma(\pi)_2 \qquad (55)$$

which means that only when the correlation coefficient $(\rho_{t,t+1})$ is equal to 1, the standard deviation is:

$$\sigma(\pi) = \sigma(\pi)_1 + \sigma(\pi)_2 \qquad (56)$$

which,as it is shown in Figure 5 simplifies considerably the Linear Programming formulation of intertemporal risk linkages. If $\rho_{t,t+1}$ is not equal to one, a different formulation is needed.

Columns / Rows	LOANS				MAD ACCOUNTS				RISK AV. COEF.	RHS
	L_1	L_2	...	L_n	Z_1	Z_2	...	Z_n		
U	$\bar{r}_1$	$\bar{r}_2$		$\bar{r}_n$					$-\emptyset$	= MAX
MAD CONSTRAINTS Z_1	$r_{11}-\bar{r}_1$	$r_{12}-\bar{r}_2$	...	$r_{1n}-\bar{r}_n$	1					≥ 0
Z_2	$r_{21}-\bar{r}_2$	$r_{22}-\bar{r}_2$	...	$r_{2n}-\bar{r}_n$		1				≥ 0
.	.	.		.			.			.
.	.	.		.			.			.
.	.	.		.			.			.
Z_s	$r_{s1}-\bar{r}_1$	$r_{s2}-\bar{r}_2$	...	$r_{sn}-\bar{r}_n$				1		≥ 0
$2\sum_{s=1}^{T} Z_s$					2	2	...	2	$-\left[\frac{\Delta^{\frac{1}{2}}}{S}\right]-1$	= 0

FIGURE 4. The MOTAD Formulation for One Planning Period.

The standard deviations of returns in each period are calculated through the MOTAD approximation procedure. The correlation coefficient can be estimated from bank data for various years.

The Model in Tabular Form for an n-Period Horizon

There are three basic types of intertemporal linkages in the multiperiod model: linkages in the asset portfolio, linkages in the liability portfolio and linkages in the risk accounts.

Intertemporal linkages in assets exists in the loan and investment portfolios. There are loans and bonds with maturity of more than one period, therefore if issued in year t-j, they are collected in year t, but also they use physical resources during their life. Similarly, in the liability side, the bank's borrowings are repaid after several periods, although there may be continuous payment of interest costs. The nature of these linkages is shown in Figure 5.

In each time period the model includes several assets and liabilities, but the general rule for specification of signs in the matrix is that all receipts of funds and supply of resources are denoted negative, while the uses of funds and demand for sources are denoted positive. The intertemporal linkages establish that net receipts in year t-1 are fully transferred to year t, hence the model does not include an annual income disbursement activity. This is equivalent to

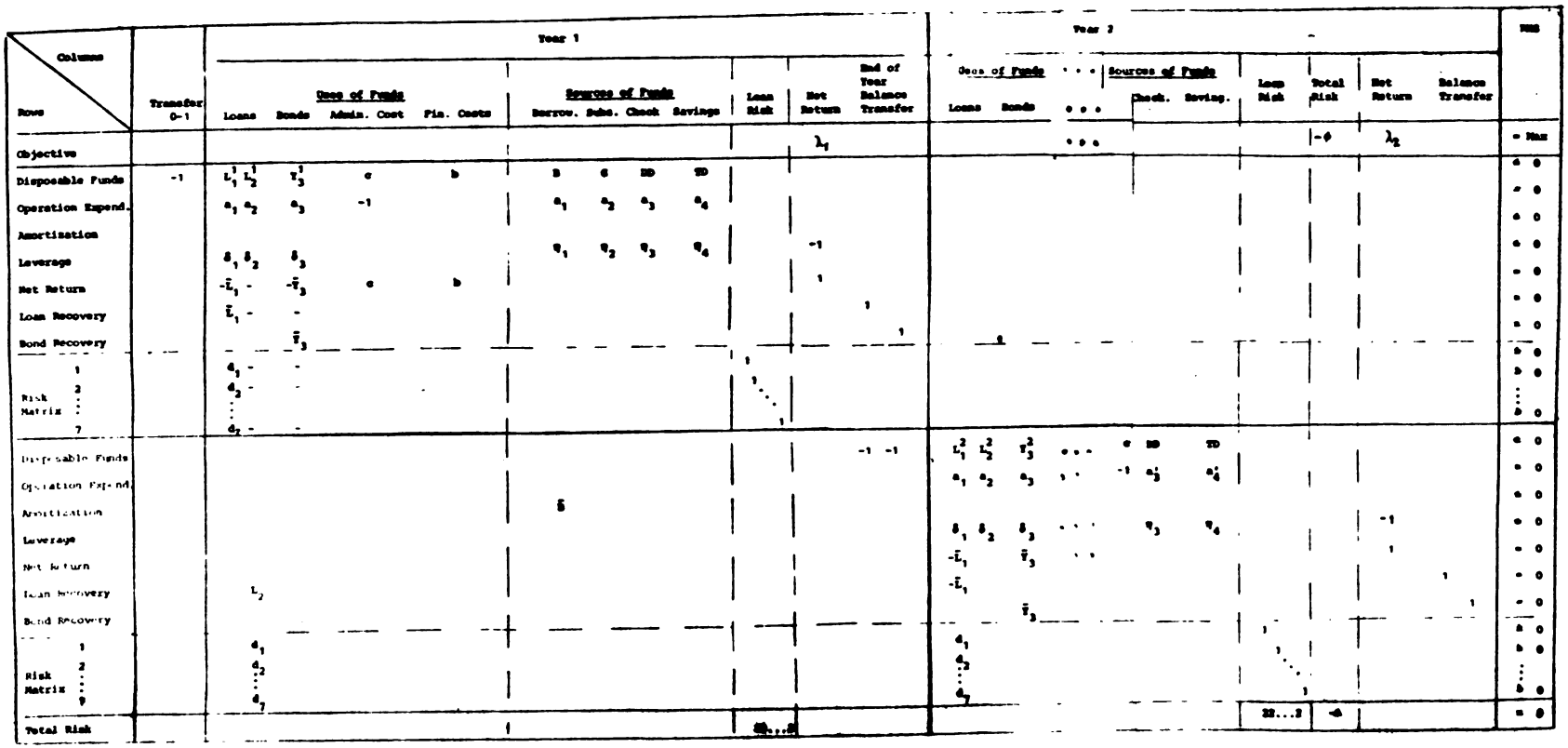

Figure 5. Algebraic Tableau of the Model for a Two-Period Horizon

saying that there is not a payment of end of period dividends, only an accumulation of wealth.

The intertemporal risk linkages formulated in Figure 5 assume a perfect correlation of returns over time. The matrices of mean of absolute deviations for each period are added and taken into account in the objective function with a given weight. This weight is given by the risk aversion coefficient (ϕ). A value of $\phi=0$ may reflect the attitude of a public institution, fully supported by the government, in which case the risk of returns is not important. Larger absolute values of ϕ will imply more concern with risk management.

Assuming that returns are normally distributed the value of ϕ can be interpreted as the level of confidence for a given standard deviation of returns. Following Baumol (1963) then values of $\phi=1.65$ and $\phi=3.15$ correspond to investors maximizing the 0.05 and 0.001 percentiles of their income distributions, provided these are normally distributed. Therefore the values of $\phi=1.65$ and $\phi=3.15$ are defined as 'reasonable' and 'extreme' levels of risk aversion, respectively.

End Notes

[1]The appropriate definition of return can vary among investors.

[2]Markowitz' original work was published in 1952 and further extended in 1959. The last edition of his book published in 1976 provides a most complete exposition and very extensive review of literature.

[3]For discussion purposes "investments" are used as a generalization, yet they can represent securities, loans, bonds, or any other type of investment activity.

[4]Quoted by Savage [1954].

[5]There are alternatives to the Markowitz-Tobin approach. Baumol [1963] offered the EL Criterion, expressed as a lower confidence limit on E equal to $L=E-K\sigma$ where E represents expected returns, K is a constant determining the probability with which E exceeds L and σ is the standard deviation of returns.

[6]See Hazell [1971], and Pomareda and Simmons [1977]

[7]In fact Beazer [1975, p.13] interprets this model as a modification of the Markowitz model in the sense that constraints are applied to eliminate the necessity of considering risk in the objective function. But it should be recognized that this approach does not take into account covariance effects.

[8]An interesting discussion of the concepts involved in determining the relevant planning horizon was provided by Modigliani and Cohen [1961]. This issue is discussed further in Chapter 4.

[9]In any LP model, the number of vectors in the solution cannot exceed the number of effective constraints.

[10]Crops, livestock, farm improvements and other.

[11]The subindices t,j,k and m could be omitted for simplicity That however, does imply that resource requirements do not change among the different types of loans and time periods.

[12](0.15) (100,000) + (0.10) (100,000) + (0.05) (300,000) = 40,000.

[13]Cohen and Hammer [1966,1967] used a discounted objective function; however they recognize that the choice of the discount rate definitely affects the optimal solution. Higher discount rates will emphasize generating cash flows earlier. Bradley and Crane [1975] used undiscounted objective functions.

[14]The value of $\Delta^{\frac{1}{2}}$ is calculated as a function of the number of periods for which information is available (S) and π=3.1416.

$$\Delta^{\frac{1}{2}} = \left[\frac{S\,(\pi)}{2(S-1)}\right]^{\frac{1}{2}}$$

CHAPTER IV

A MODEL FOR THE AGRICULTURAL DEVELOPMENT BANK OF PANAMA (ADBP)

Background

The Economy and the Agricultural Sector

Panama is one of the smallest countries in Latin America with a population of near two million people, and an annual Percapita GNP of only U.S.$660. Average per capita GNP has not increased during the past decade, yet the distribution of income has improved. This has been largely due to a significant amount of public investment in social programs. The latter has put the country in serious indebtness, as the public debt rose from U.S.$237.75 million in 1969 to U.S.$1645.26 million in 1979. Furthermore, the public debt in 1979 represented 85.5 percent of GNP, while in 1970 it accounted for only 24.7 percent of GNP [IDB, 1981; p.107] as shown in Table 2.

As in other Latin American countries, the agricultural sector is of importance in the local economy. Nevertheless, the contribution of Agriculture to GNP has decreased from 19.4 percent in 1969 to 16.0 percent in 1978. The sector of commerce and international trade is the most important, and this is to a great extent due to the existence of the Panama Canal.

The country's main exports are coffee, bananas, shrimp and oil derivatives, but they have not increased enough to reduce

the balance of payments deficit. This has widened considerably in the last decade, as imports of oil and capital inputs rose steadily. Also food imports are an important component in the overall import bill, accounting for approximately 7 percent. In absolute terms however, food imports rose from U.S.$20.85 million in 1969 to U.S.$61.03 million in 1978.

Panama's tax laws have encouraged internacional commercial banking, hence Panama City has become the banking center for Latin America. There are currently 115 foreign and domestic banks operating in Panama with a total of 181 offices. The importance of this activity is significant in the local economy, as it provides employment for several thousand people, yet most of the financial resources are channeled towards other Latin American countries. In 1969 the outstanding loans to domestic borrowers were U.S.$331.81 million, while those to foreign borrowers were only U.S.$101.89. By 1979 the proportions reversed dramatically and outstanding domestic loans were U.S.$1843.25 million while foreign loans were U.S.$8495.22 million.

The flourishing of the international banking industry has attracted some of the best local talent. As a result the two national development banks face serious management and personnel problems as they can not offer competitive salaries and privileges. Bernal, Herrera and Joly (1982) suggest that this lack of personnel is one of the major reasons for a

Table 2. Panama, Major Economic Indicators, 1969-1978.

Variable	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Gross National Product (In 1960 Prices)	836.30	894.50	972.60	1033.80	1101.20	1130.10	1137.10	1133.60	1171.60	1203.60
Agric. as% of GNP	19.41	18.0.	17.18	16.63	16.00	15.50	16.14	16.09	16.77	16.00
Per Capita GNP (In 1960 Prices)	590	613	648	670	694	693	678	657	660	660
Government Debt	238.73	285.53	328.40	405.25	476.86	590.38	772.00	855.20	956.07	1412.79
Population	1391	1434	1478	1523	1570	1618	1667	1719	1771	1825
Number of Bank Offices	95	114	140	152	169	178	185	187	184	181
Assets of Capital of all Banks	577.75	840.34	1166.85	1887.76	3578.22	6475.23	8433.38	9864.94	12434.64	16064.03
Outstanding Domestic Loans	331.81	421.73	562.86	764.20	1024.71	1352.28	1525.33	1658.28	1765.52	1843.25
Outstanding Foreign Loans	101.89	243.54	375.43	808.19	1207.81	2890.91	4461.22	4742.57	6279.99	8495.22
Food Imports	20.85	24.54	34.18	33.84	42.04	55.51	55.23	54.02	58.13	61.03
Total Imports	278.67	326.35	358.97	401.12	454.00	755.70	815.57	779.73	777.76	844.80
Total Exports	108.82	106.25	114.88	121.11	135.26	204.33	280.22	228.10	243.05	244.24
Consumer Price Index (1975=100)	68.5	70.7	72.0	75.9	81.1	94.8	100.0	104.0	108.7	113.3
Index of Agric. Prices (1975=100)	-	-	100.0	102.4	107.6	126.3	142.7	146.8	157.0	175.5

Source: Panama, Contraloría General de la República, Panamá en Cifras, 1974-1978, Contraloría General de la República, Panamá, 1979.

defficeint service and low loan repayment in the Agricultural Development Bank of Panama (ADBP).

The agricultural sector of Panama is tipified by small farms. As shown in Table 3, more than 95 percent of the farms are of less than 50 hectares, while only a few farms are of more than 500 hectares. The latter group includes sugar cane plantations and some large rice producing companies.

As shown in Table 4 rice and corn are the two important food crops, while coffee, tobacco and sugar cane are the major export crops. As evidenced in the analysis of the following sections, formal government and private credit is assigned mostly to these crops and cattle.

Financial Resources and Policies for Agriculture

As in most developing countries there is a stratification in the agricultural credit market. Commercial banks and the two development banks are the sources of institutional credit, each serving a particular clientele and operating under different criterion.

Commercial banks supply the largest proportion of credit to agriculture but, practically all of it is allocated to large enterprises producing sugar cane, rice and beef cattle (see Table 6). Most of these loans are very large and in fact the Fiduciary Bank and the Chase Manhattan Bank do not provide loans of less than U.S. $25,000 and U.S. $15,000 respectively

Table 3. Panama, Land Use and Size Distribution of Farms.

Variable	1950	1960	1970
Land Use			
Number of Farms	85,473	95,505	105,272
Total Acreage (has)[a]	1,159.082	1,806,452	2,098,062
annual crops	-	205,048	213,607
perennial crops	-	125,378	110,764
cultivated pastures	427,557	683,606	964,758
natural pastures	124,530	134,723	176,037
fallow lands	213,563	222,971	217,436
other lands	156,820	134,726	415,460
Size Distribution of Farms (has)			
< 50	81,755	88,713	96,654
50-100	2,407	4,329	5,526
100-500	1,157	2,239	2,773
> 500	154	224	319

Source: Panama, Contraloría General de la República, Panama en Cifras, 1974-1978, Panama, 1979.

[a] One hectare (ha) = 2.45 acres

Table 4. Panamá, Area and Production of Main Crops.

Area of Main Food Crops (has)	1974/75	1975/76	1976/77	1977/78	1978/79
Rice	112,200	115,370	122,350	109,980	99,110
Corn	75,500	74,320	83,150	82,780	68,600
Beans	16,100	16,590	15,560	14,850	11,770
Production of Main Expert Crops					
Coffee (1000qq)[a]	99,300	105,850	103,100	121,600	135,500
Tobacco (1000qq)[a]	17,660	24,510	28,310	30,650	33,290
Sugar Cane	1,898	2,121	2,641	3,039	2,892

Source: Panama, Contraloría General de la República, Panama en Cifras, 1974-1978. Panamá, 1979.

[a] 1 quintal (qq) = 46 kg.

Table 5. Panama, Credit from Public and Private Sources by Sector (million U.S.$).

Activities	1975	1976	1977	1978	1979[a]
Total	8846.14	10498.16	10240.14	14678.76	19940.61
Public	266.21	351.02	334.82	209.56	396.40
Domestic Sector	260.21	351.02	334.83	209.56	376.40
Agriculture	5.68	3.25	7.75	4.32	7.21
Livestock	17.35	14.74	28.11	22.74	25.63
Fisheries	.01	0.01	0.02	-	-
Other Activities	237.17	333.02	298.96	182.30	343.56
External Sector	6.00	-	-	0.20	-
Private	8579.93	10147.14	9905.32	14469.20	19564.211
Domestic Sector	1647.39	1631.14	1664.54	1853.25	2282.68
Agriculture	69.28	69.49	88.87	66.85	68.39
Livestock	48.45	39.43	36.23	39.77	40.93
Fisheries	8.55	4.54	7.08	5.51	4.17
Other Activities	1521.11	1517.68	1532.36	1741.12	2169.19
External Sector	6932.53	8516.01	8240.78	12615.95	17281.53

[a] Preliminary

Source: Panama, Comisión Bancaria Nacional, 1981

Table 6. Panama, Loans from Private Banks[a] to the Agricultural Sector (1,000 U.S.$).

Subject	1977/78	1978/79	1979/80	1980/81
Crops				
Rice	28,860	22,698	23,334	25,443
Sugar Cane	53,260	33,996	32,908	36,219
Coffee	3,591	6,581	8,648	5,057
Other Crops	3,198	3,572	3,500	3,533
Total	88,869	66,847	68,390	70,254
Livestock				
Cattle	29,388	33,380	32,522	35,866
Chickens	5,365	4,075	6,399	5,431
Other	1,574	2,217	2,006	3,221
Total	36,227	39,772	40,927	44,418
Total	125,096	106,619	109,317	114,672

Source: Panama, Dirección de Estadística y Censo y Comisión Bancaria.

[a] Includes Citybank, Chase Manhattan Bank, Banco Fiduciario, Banco de Colombia, Banco de Santander, Bank of America, Banco de Comercio Exterior, Marine Midland Bank, Sociedad de Bancos Suizos de Panama and Banco Internacional.

(Bernal, Herrera and Joly, 1982). In the selection of their clientele, commercial banks rely on past records and profitability of the enterprises as the most important criteria.

The National Development Bank (BNP) is one of the two government banks. As shown in Table 7 it serves primarily other sectors but approximately 10 percent of its portfolio is allocated to agricultural and livestock loans of medium and large size. Inspite of being a development bank, it follows quite strong loan selection criteria and it is tipified by a rather high loan recovery rate.

The Agricultural Development Bank of Panama (ADBP), is the government bank that serves exclusively the agricultural sector. It provides credit for small, medium and large individual farmers and cooperative groups. Its portfolio is widely diversified by crops and livestock in the nine provinces of Panama. The bank provides credit at the lowest interest rates and relies heavily on government subsidies. More on the structure of the ADBP will be provided in the following sections.

Credit for agriculture provided by all banks is under preferential conditions. In October of 1980 the National Banking Commission set the interest rate on agricultural loans by commercial banks equal to 14.25 percent, while the market rate was 18 percent. Under these conditions clients were granted a subsidy that between October 1980 and October 1981 accounted for U.S.$4.5 million (La Estrella de Panama, January

Table 7. Panama, Agricultural and Other Loans from the National Development Bank (BNP).

Sector	1976-77		1977-78		1978-79		1979-80	
	No.	1000US$	No.	1000US$	No.	1000US$	No.	1000US$
Agriculture	205	7745	230	4320	385	7206	1022	7250
Livestock	1003	28104	1212	22748	2028	26114	2545	30516
Other Sectors	23221	266709	19607	147038	32064	347670	28185	458617
Total	24429	302559	19607	174102	34477	381010	31752	516389

Source: [Panama, Banco Nacional de Panamá, Memoria Anual, various issues]

Table 8. Panama, Crop and Livestock Loans Provided by the Agricultural Development Bank (1000 US$).

Item	1977-78	1978-79	1979-80	1980-81
Rice	7177	7632	12962	13522
Coffee & Cocoa	-	722	3524	3423
Vegetables[a]	1053	1399	2047	2959
Corn & Sorghum	2477	2432	3457	4622
Industrial Tomatoes	1038	1068	1063	1806
Cattle	6261	8254	11249	15446
Other Livestock[b]	668	1619	2485	1854
Other Loans[c]	1021	1664	2575	3072
Total Loans	19695	24790	39362	47704

Source: Panama, Banco de Desarrollo Agropecuario. Memoria Anual, various issues.

[a] Includes onions, potatoes, melons, and other vegetables.

[b] Includes poultry, pigs, and minor species

[c] Includes beans, sugar cane, and other crops.

15, 1982). Prior to 1980 the National Bank Commission, pursuant to article 1, Law 95 of November 1974 had been granting a similar compensation to banks and finance institutions that provided credit to agriculture and manufacturing industries. The credit provided by the BNP is between 1 and 2 percent below the 14.25 percent and the loans from the ADBP vary between 8 to 11 percent.

The Agricultural Credit Insurance Program

The Agricultural Insurance Institute (ISA) began its operations in 1976 in close liasson with the ADBP. The program provides credit insurance and hence in first instance it protects the loans issued by the ADBP. The program has expanded rapidly (see Table 9) and currently insures approximately 30 percent of the ADBP portfolio.[1] It insures only rice, corn, sorghum, beans and industrial tomatoes and beef cattle. It operates only in six of Panama's nine provinces. The administration of ISA plans to cover an increased proportion of the ADBP portfolio, yet this would depend on the rate of growth of the ADBP activities and the desirability for insurance among self financed farmers and commercial banks.

Under the current rules and regulations of ISA, the total coverage level for a crop is 70 percent of the sum of the direct production costs. However, when a compensation payment is made, actual production costs are used when these are smaller than the stipulated production costs in the program.

Table 9. ISA - Summary of Insurance Operations, 1976/77 - 1980/81.

Variable	1976/77	1977/78	1978/79	1979/80	1980/81
COMBINED PORTFOLIO					
Coverage (US$)	25,898	1,129,579	2,636,498	8,131,592	13,114,208
Number of Policies issued	9	351	809	2,114	2,722
Indemnities Paid (US$)	1,588	17,784	102,462	194,642	402,143
Net Premiums (US$)	1,165	58,723	113,815	331,567	519,579
Loss Ratio	1.36	0.30	0.90	0.59	0.77
CROP INSURANCE					
Coverage (US$)	25,898	1,129,579	1,887,511	4,575,710	6,806,637
Hectares Insured	122	5,410	7,307	13,988	16,183
Number of Policies issued	9	351	525	1,284	1,446
Indemnities Paid (US$)	1,588	17,784	93,731	130,451	290,013
Net Premiums (US$)	1,165	58,723	103,741	269,630	356,261
Loss Ratio	1.36	0.30	0.90	0.48	0.81
LIVESTOCK INSURANCE					
Coverage (US$)			748,987	3,555,882	6,307,571
Number of Head Insured			3,392	11,677	18,969
Number of Policies issued			284	830	1,276
Indemnities Paid (US$)			8,731	64,191	112,130
Net Premiums (US$)			10,074	61,937	163,318
Loss Ratio			0.87	1.04	0.69

Source: [ISA, Memoria Anual, various issues]

Somewhat asymetrically, when an actual production cost is higher than it was projected to be in the crop program, the lower figure is always used. Furthermore, compensation payments are made on the basis of the costs incurred up to the date of the disaster. Since a large proportion of the crop losses come soon after planting, this means that the actual coverage level for most cases where compensation payments are made is only about 50-60% of the total production costs. This has been a sore point, and the ADBP recently used its influence to get ISA to pay farmers experiencing complete loss of crop the full value of the insurance coverage. Hogan [1981] suggested that this is going to have a significant impact on ISA's loss ratios. In this, ISA is facing a situation similar to that faced the Mexican insurer, (ANAGSA) in the SAM pilot areas.[2] In Mexico insurance is being used as a contingent income transfer, in that the compensation payment exceeds the actual coverage [Hogan, 1981]

The administrative costs of ISA run about 6% per dollar of coverage, which makes it slightly larger than the average premium rate (ISA, 1980). ISA's average loss ratio for the last three years is approximately 73% for its crop portfolio and roughly 86% for its livestock portfolio. ISA receives administrative subsidies from the Government of Panama that account for approximately two percent of total coverage.

Within the Agricultural Sector two other institutions play an important role in the effectiveness of credit policies and the use of agricultural credit. The Ministry of Agricultural and Livestock Development (MIDA) is responsible for supplying the ADBP and ISA the technical information for the crop and livestock programs which will receive official credit and insurance. The MIDA takes a somewhat more predominant role in overall agricultural sector credit planning, as it is also responsible for providing the technical assistance to credit users, and it has the responsibility for the creation and continuing support of the agrarian reform settlements.

The Agricultural and Livestock Marketing Institute (IMA) of Panama sets price guarantees each year which are used in planning the next crop production cycle. These prices are used in establishing loan and insurance programs. IMA also functions as a crop storage agency, although there are frequent reports of storage capacity being exceeded, with the result that farmers are often forced to sell to local traders at prices below the guarantee. Thus, price stabilization has a rather qualified meaning in Panama. Lastly, IMA is responsible for importing foodstuffs which local producers are unable to supply in sufficient quantity--principally maize, beans and sometimes rice. Again, price stabilization and food import policies are normally coordinated with technology, credit and insurance policies, but an adequate understanding of how these policies interrelate seems lacking.

The ADBP Portfolio

Financial Structure of the ADBP

The ADBP is the government bank to serve the agricultural sector. As such it fulfills government goals and policies; yet its current institutional design, availability and quality of resources and financial policies limits its capacity to provide enough financial resources to agriculture. Furthermore, unless significant changes are introduced, it is not likely that the bank could grow at a faster rate. Nevertheless, the current administration is very interested in exploring alternative growth strategies.

The ADBP's balance sheet (Table 10) is typical of the several specialized state-owned agricultural development banks. On the asset side the bank holds basically loans and only in the last two years has it included some bonds of government debt. On the liability side the bank rests primarily on long term borrowed funds, yet short term borrowings have recently increased considerably. The bank's net capital accounts for most of total capital, but as it is observed, the government contribution is also a major portion of total capital. In significant contrast with a liability-diversified bank, the ADBP does not handle any savings and checking accounts.

The importance of loan recovery on the sources of funds is appreciated from the data in Table 11. Loan recovery represents 72 percent of internal resources. Interest earnings on loans on

Table 10. ADBP, Balance Sheet, 1978-79 and 1979-80 (millior US$).

Assets			Liabilities & Capital		
Description	1978/79	1979/80	Description	1978/79	1979/80
Cash	1.754	1.698	Borrowed Funds:		
			Short Term	3.843	9.110
			Long Term	17.416	22.684
Loans Outstanding	60.333	60.796	Pending Accounts & Bonds:		
			Short Term	2.366	2.906
			Long Term	1.886	1.886
Accounts Outstanding	8.289	12.712			
			Other Liabilities	0.541	0.550
Investments (Negotiable)	0.054	8.647[a]	Interest Earnings not Collected	2.049	-
			Total Liabilities	28.113	37.128
			Net Capital	37.268	37.268
Real Assets	1.517	1.590			
			Surplus (Deficit)	2.082	0.448
Fixed Assets	7.828	8.571	Contribution of the Government	17.955	20.811
			Net Return (loss)	0.874	0.938
Other Assets	0.700	0.602	Total Capital	52.265	57.589
Total Assets	80.379	94.717	Total Liabilities & Capital	80.378	94.717

Source: Panama, Banco de Desarrollo Agropecuario, Memoria Anual, 1980

[a]Includes Treasury Debt for US$ mi. 8.600

Table 11. ADBP, Sources and Uses of Funds, 1979/80 and 1980/81 (million US$).

Sources of Funds	1979/80	1980/81		1979/80	1980/81
Internal Resources			**Operating Expenses**		
Loan Recovery	23.809	25.365	Salaries & Honorariums	3.327	3.572
Interest Earnings	3.747	4.802	Other Operating Expenses[b]	0.870	1.517
Government Subsidy	2.943	6.119	Capital Disbursements	0.219	0.214
Other Resources[a]	2.369	1.535	Total	4.416	5.304
Total	32.868	37.823			
External Resources			**Financial Expenses**		
Borrowing from Domestic Banks	21.400	22.739	Repayment of Borrowed Funds	17.379	19.391
Borrowing from International Agencies			Interest Payments	2.611	3.802
			Other Obligations	0.387	.099
IDB	5.915	8,311	Total	20.387	23.293
USAID	1.179	0.069	**Loans**	33.388[c]	37.869
World Bank	0.780	0.676			
Total	29.274	31.795			
Total Sources	62.143	69.618	**Total Uses**	62.143	69.818

[a] Sales of Property and others

[b] Includes vehicles, maintenance of offices, equipment, etc.

[c] This number is not equal to the one on Table 10(39.362); hence here the ADBP includes only actually disbursed funds, while the 39.362 includes commited but not fully disbursed funds.

the other hand, account for only 11 percent of total internal resources. As borrowing from international agencies has become more difficult, the bank relies currently on heavy borrowings from domestic banks. These borrowings currently account for 73 percent of external resources. Furthermore, an increasing portion of these funds are short term borrowings.

The uses of funds reveal the high operating costs, and strong demands for repayment of borrowed funds. Hence, the bank is left with slightly over fifty percent of its resources available for loans. It is evident that issuance of new loans is severely affected by current financial obligations and the operating budget of the bank.

Characteristics of the Loan Portfolio

Lending is the primary activity of the bank; and therefore an examination of the characteristics of the loan portfolio became an essential part of this research. The bank does not have processed information on the characteristics of its loan portfolio disaggregated by crop, size of operation, insurance usage and maturity, as needed for the purposes of this research. Also the available aggregated information by crops and livestock loans did not provide data on the characteristics of each loan in terms of amount disbursed, interest rate, amount collected, administration costs, maturity structure of amortization, etc.

To obtain the required information, consistent with the model proposed in chapter 3, a sample of loans issued by the eight most important agencies was taken.. A completely random sample was taken from the agencies files for the years 1974 through 1980 seeking approximately 10 percent of the loans issued in each agency in each year, for each of the seven major items shown in Table 8. The original sample included 1366 loans.

It was realized, during the processing of the loans, that most of the medium and long term loans issued after 1977/78 had not matured yet, hence making this set useless for the analysis. Those observations were dropped from the file, leaving a total of 900 observations.

The set was disaggregated by size class and insurance class. The size classes were in U.S. dollars:

$$k = 1, \quad < 1{,}000$$
$$k = 2, \quad 1{,}000 - 10{,}000$$
$$k = 3, \quad > 10{,}000$$

and the insurance classes included:

insured (j = 1) and
not insured (j = 0)

Hence, for each item there could be as many as six classes. Therefore, there could be as many as 42 loan groups (7 x 3 x 2). In practice however, the number of classes is a smaller set.

This is because corn, coffee and industrial tomatoes are produced by small farmers while rice and livestock are produced by all groups of farmers. However, the insurance institute does not insure the very large loans nor the very small ones and also ISA insures only three of the five crops and livestock.

An important part of the bank's loans are given to cooperatives and farm associations. In 1979/80 and 1980/81 this form of credit accounted for 18 and 21 percent of the total volume of credit. Most of this however, (approximately 65 percent) was for rice production. This form of credit was provided in loans of more than $200,000 and some of them were as large as $200.0 0. Currently the program services 200 farmers' groups that included approximately 8000 families and 46 cooperatives with near 2'000 members.

The cooperative credit has resulted in a mixed experience for the bank. On one hand it reduces considerably the administration costs, as the average size of a loan is rather large, although it needs more time than an individual loan. On the other hand, the cooperative movement in the agricultural sector of Panama is not very successful and this contributes to low repayment on bank loans. Given the importance of this line of credit, an additional loan category was included: Large Loans for associated rice producers. Information was not available through the sample of other items, nor for insured rice for this group of producers.

As shown in Table 12, 26 loan classes were distinguished. The summary information for each loan class revealed important characteristics. First, there is a significant difference in the maturity of crop loans versus livestock loans, as the later are for the purpose of herd development, although some may be for fattening. Second, for the non-insured loans the actual maturity (average repayment period) is significantly longer than the expected maturity. For the insured loans, however, the actual maturity is equal, and in some cases even smaller, than the expected maturity. This implies that the administration cost of insured loans is smaller. Fourth, the interest rate on loans for the same crop (except rice) increases with the size of the loan, reflecting a trade-off between the rate of interest and length of the repayment period.

The data reveal also important differences in profitability of the loans. In more than one case this profitability was found to be negative, which indicated that the recovery was so low that the bank could not cover even the interest cost.

Information on resource requirements for the administration of the loans was not available from the files. It was suggested however, that a good proxy for the administration cost of maintaining a loan on the books will be one day of loan officer time per month during the duration of the loan. Hence for non-insured rice loans of class one for example, the administration cost will be given by 13.20 man-days of which 12.00 would

Table 12. ADBP, Characteristics of the Loan Portfolio.

	Variable	Rice			Corn		Industrial Tomatoes		Vegetables		Coffee		Livestock		Other Loans		Assoc. Credit
	class	1	2	3	1	2	1	2	1	2	1	2	1	2	1	2	3
Not Insured Loans	Amount Disbursed ($)	449.	5013.	21638	440.	1368	433.	1619	505.	2376	490.	2447	611.	3988.	513	2456	36256.
	Nominal Rate of Interest (%)	9.25	9.61	9.69	8.88	8.84	8.89	9.00	8.75	9.37	8.59	9.13	9.17	9.60	8.97	9.26	8.44
	Amount Collected ($)	475.	5257.	22520	473.	1473	457	1704	530	2500	524	2594	704	4574	540	2635	37867.
	Net Interest ($)	27.	235.	882.	33.	106.	36.	86.	24.	153.	33.	147.	93	586.	28.	179	1611
	Actual Rate of Interest (%)	6.41	5.33	5.36	7.57	6.73	5.64	7.08	5.72	6.80	6.46	6.40	6.95	6.73	6.58	6.60	4.69
	Expected Duration (months)	7.85	7.60	8.43	8.57	8.38	4.55	5.91	6.22	6.00	10.81	10.51	31.33	37.36	15.57	11.36	14.10
	Actual Duration (months)	13.20	11.74	12.06	12.81	13.5	14.17	12.80	11.70	9.96	12.58	12.51	28.33	33.24	15.24	13.39	13.79
Insured Loans	Amount Disbursed ($)	589	4722	22275	748.	2286	394	1597	-	-	-	-	-	5034	693	3703	-
	Nominal Rate of Interest (%)	10.10	10.36	11.6	9.5	9.96	9.17	10.83	-	-	-	-	-	12.08	9.67	10.07	-
	Amount Collected ($)	606	4886	23299	799	2387	403	1658	-	-	-	-	-	5633	718	3878	-
	Net Interest ($)	17.0	164.	1023	51.	101	11.3	61.	-	-	-	-	-	599	25.	174	-
	Actual Rate of Interest (%)	8.67	5.86	6.78	9.24	8.75	8.86	9.95	-	-	-	-	-	9.42	6.58	6.49	-
	Expected Duration (months)	6.83	7.69	8.01	6.50	6.79	5.08	5.87	-	-	-	-	-	23.66	5.08	5.24	-
	Actual Duration (months)	4.00	7.18	8.28	8.80	8.20	4.50	4.88	-	-	-	-	-	18.00	6.67	8.05	-

Source: [Banco de Desarrollo Agropecuario de Panamá, Sample of 900 loans issued between 1974 and 1980].

Note: 1 = small loans of less than US$1000

2 = medium loans of more than US$1000 but less of US$10000

3 = large loans of more than US$10000

be charged in year t and 1.20 in year t+1. A fixed cost was also suggested for the issuance of each loan; this however, varies according to the size of the loan. In addition, there could be differences in costs by items and by regions. The specific costs used in the model are discussed in the following section.

The available data did not allow estimation of a functional relation between loan supervision and loan recovery. It was indicated that each loan officer handles 60 new loans, during the expected maturity. When a loan becomes overdue it is handled by a loan recovery officer. Their job is limited to chasing the farmer around and trying to get him to pay back the loan. However, there is little the bank can do to enforce loan collection by legal means.

Financial, Physical and Institutional Constraints

The bank faces a number of constraints of a financial, physical, and political nature regarding its institutional design. All these constraints contribute, and to great extent determine, the current structure and performance of the bank and its perspectives for growth. These constraints are taken as the initial conditions in the model discussed in the next section. Nevertheless, a number of assumptions are made regarding their changes over the planning horizon for the bank. The sources of funds are the following:

Internal Resources	1000 US$
loan recovery	23,809
interest earnings	3,747
government subsidy	2,943
other resources	2,369
External Resources	
Borrowings	
CB's	21,400
IDB	5,915
WB	0,780
AID	1,179
Operating budget	4,416

Besides the monetary input that these financial resources represent in the first year of the planning horizon, it is also necessary to specify the repayment conditions on borrowings and these are discussed in the following section. The operating budget for the bank is determined a priori by the board of directors and hence it is also a condition that will influence the bank's allocation of resources.

	1000 US$
salaries and honorariums	3,572
other operating expenses	1,517
capital disbursements	214

As far as resource needs and availability it is important to recall the seasonality in loan demand. The great majority of agriculture is rainfed and the rains begin in April. Therefore, the plantings for most crops are initiated at this time. As it can be expected, the issuance of loans is heavier during the second and third quarters, because the bank can not approve and issue all loans during the planting season.

The seasonality in loan demand is shown in Table 13. Most loans for rice, corn, sorghum and coffee are issued in the second and third quarters. Industrial tomatoes are grown under irrigation and as a second crop, hence their plantings begin in November. Livestock and other loans are issued throughout the year.

As far as physical constraints, it should be recognized therefore, that a specification of available physical units is likely to underestimate the seasonal bottlenecks for loan administration and supervision. The bank currently has 162 vehicles, 169 loan officers and a total staff of 640 persons. Given the seasonality of the crop cycles the demand for these resources varies over the year. Hence, during some months these resources may be sub-utilized while at other times the demand would largely exceed the supply. It would be at these times when loan requests are not evaluated properly and when loan supervision is below optimal.

Table 13. ADBP, Number of Loans Issued by Quarter, 1978-1980.

Purpose	1978				1979				1980			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Total	773	1600	1638	1462	1313	1759	1135	1349	1670	2237	2515	1598
Rice	28	463	191	65	97	374	251	84	44	416	183	39
Corn & Sorghum	2	301	391	83	399	259	475	123	342	197	638	167
Industrial Tomatoes	72	1	3	347	126	14	1	323	172	7	4	294
Vegetables[a]	70	112	120	213	90	150	100	237	69	170	160	244
Coffee	31	146	199	38	69	150	245	36	79	239	460	75
Cattle	258	342	637	538	393	501	592	452	378	487	730	326
Other[b]	312	235	97	178	139	311	529	94	586	721	340	453

Source: [Contraloría General de la República, Panamá, 1981]

[a]Includes potatoes, onions, and other vegetables.

[b]Includes other crops and livestock and other purposes.

Considering the bank as an aggregated decision unit, one oversimplifies the extent of some institutional constraints in terms of goals of the regional agencies. Nevertheless, it is possible to specify some of the aggregate policies and goals. The most important of these is the interest of serving the small and medium commercial farmers. Within the current administration there are no specific number of small and medium loans that must be issued, nor specific volumes of credit for particular crops, as these are determined by demand. However, it was considered appropriate (reflecting the bank's development policy and previous experience) to issue at least 2000 small loans regardless of the purpose.[3] As far as a balance in the loan portfolio, the bank tries to assign as much as two thirds of the funds to crops and one third to livestock and other items. This constraint was not imposed on the model solutions.

An important constraint is currently imposed on the issuance of insured loans. This is determined by the capacity and financial policies of ISA. Currently ISA does not provide insurance for coffee and vegetables (except industrial tomatoes and onions) and the maximum coverage is 80 percent of the value of each loan. In 1980/81 ISA provided coverage for 6.806 million U.S.$ of crop loans and 6.307 million U.S.$ of livestock loans. Also, the number of policies that ISA can administer is limited by its available resources to pay personnel, the number of vehicles and

its operating budget. In 1980/81 ISA issued 2722 policies (1446 for crops and 1276 for livestock).

The bank administers separately the loans for individual and associated producers. The bank is most willing to benefit this later group, yet in doing so runs into interesting problems. On one hand the administration of these rather large loans implies cost efficiency and hence a desirability for the bank. On the other hand however, the experience with associated producers is not the best in terms of loan recovery. In addition these loans are given at preferential rates. Information was not available in terms of performance of insured loans for associated producers, hence this alternative was not considered. Therefore, given the bank's political objectives, it was assumed that there is the intent to assign at least 100 loans to associated producers, but not more than 240 loans because of the number of viable borrowers.

The above constraints are considered the most important ones. They could be interpreted as the determinants of the performance of the ADBP. When these constraints are taken into account in the bank's model one can appraise their net effect on the instituition's development role.

BANK: A Multiperiod LP Model for the ADBP

This section discusses the actual coefficients used in the model for the ADBP. These coefficients are elaborated using the information in the previous section to structure the model in matrix form. The discussion refers first to the coefficients for one planning period, thus beginning by the identification of rows and columns of the model in one year. A separate section is devoted to discussing the calculation of the risk measures in the loan portfolio. Finally, a section explains briefly the intertemporal linkages. It should be mentioned at this point that the technical coefficients (except for the right hand sides and bounds, and entries in the objective function) are equal for all years in the model. However, the sub-matrix for the first year includes some additional vectors to account for outstanding loans and borrowings. These borrowings impose heavy financial obligations on the bank during the second year of the planning horizon. At the same time beginning in the second year, the bank does not receive any soft loans from international financial agencies.

There are two forms of the model. The first form (A) describes the current structure of the bank i.e., the vectors for demand and time deposits, and investment activities on bonds are fixed equal to zero. In the second form (B) the bounds on those vectors are released.

The Matrix for one Planning Period

The model is structured with reference to the sources and uses of funds as shown in Table 11. Each entry in Table 11 becomes an activity or a group of activities in each annual transactions matrix. This annual transactions matrix for year 1 for example, includes the following vectors:

Sources of funds

TLR00.01 , transfer of net loan recovery funds from the previous period

TIE00.01 , transfer of investment earnings from the previous period

BGS...01 , government subsidy

BOR...01 , other resources[4]

BCB...01 , borrowings from commercial banks

BID...01 , borrowings from the IDB

BWB...01 , borrowings from the World Bank[4]

BAI...01 , borrowings from the USAID[4]

DSA01.01 , deposits as savings accounts of 1000 dollars

DSA02.01 , deposits as savings accounts of 10000 dollars

DSA03.01 , deposits as savings accounts of 100000 dollars

DCH01.01 , deposits as checking accounts of 10000 dollars

DCH02.01 , deposits as checking accounts of 100000 dollars.

Uses of funds

COE...01 , operating expenses

CPN...01 , office staff costs

CLT...01 , loan officers costs

CLT...01 , collection officer costs

ABF...01 , amortization of borrowed funds

AIP...01 , amortization of interest payments

LRI01.01 , loans for rice (RI), not insured (0) of less than $1000 (1), and other 27 classes of loans

.

.

.

IBD01.01 , investments on bonds of 1000 dollars maturing in one year

IBD02.01 , investments on bonds of 1000 dollars maturing in three years

TNR...01 , net balance at the end of period.

It should be noted that the form A of the model, which reflects the current organization of the ADBP, fixes equal to zero the vectors for savings and checking accounts and investments on bonds. Therefore, the bank acts as a specialized lending agency. In both forms of the model there is no constraint on borrowings from commercial banks and there is no allowance for borrowings from international development financial agencies after the first year. In both forms of the model the borrowings form the IDB, the World Bank, AID and the Commercial

Banks in year 1 are fixed, as they reflect the obligations already acquired. The value of the other vectors in the model is determined endogenously.

A group of activities is defined in physical units, i.e. number of checking accounts, savings accounts, loans and bonds. These vectors are defined in physical units because they use physical resources. Therefore, the model could choose from alternative denominations, and maturities trying to make the best use of its scarce resources. Other activities are pure financial transactions and these include transfer of funds, borrowings from commercial banks, operating expenses and amortizations.

The model's equations include a number of financial, physical and institutional constraints and the risk balance equations. The first equation in the model is the objective function (utility over time) to be maximized. In period one, as in the other time blocks, the following equations are distinguished:

financial constraints

EDP...01	disposable funds
EOE...01	operating expenses
ABF...01	amortization of borrowed funds
AIP...01	amortization of interest payments
ELR...01	loan recovery

ENR...01	net returns
RLE...01	leverage requirement

physical constraints

RPN...01	office personnel time requirements
RVH...01	vehicle requirements
RLT...01	loan officers' time requirements
RCT...01	loan collectors' time requirements

institutional constraints

RL1...01	number of small loans (1)
RL2...01	number of medium loans (2)
RL3...01	number of large loans (3)
RIC...01	value of insured crop loans
RIL...01	value of insured livestock loans
RIP...01	number of insured policies

risk constraints

RRI01.01	return deviations in year 1 (1974)
.	.
.	.
.	.
RRI07.01	return deviations in year 7 (1980)
RRITO.00	total mean of return deviations over the planning horizon.

Several other equations could have been included for accounting purposes. However, it was planned that a report writer would be used to present the most important information, but this report writer could not be obtained.[5] The columns vectors and equations are repeated for all years. For a 10-year planning horizon the model has 512 column vectors and 298 equations. The later include those equations to collect disbursed funds maturing after the tenth year.

As a general rule, all entries in the matrix which represent an inflow of capital (supply) are designated with a minus (-) and, all entries which represent an outflow (demand) of capital are designated with a plus (+). In the objective function costs are negative (-) and returns are positive (+).

Returns and resource requirements for the various loan and investment activities were calculated according to the following criteria.

a. There is an issuance cost for each loan. This cost varies according to the size of the loan in the following way:

loan class	$/loan
small (1)	10.
medium (2)	20.
large (3)	30.

This issuance cost increases with the loan size because, as the loan is for a larger amount, it demands more time to be evaluated before the disbursement is authorized.

b. The requirements of loan officers' time are estimated considering that a loan officer is in charge of a loan during the expected maturity period. When the loan becomes overdue it passes to the collection department. As the expected maturity is calculated in months, the requirements of loan officer time are specified in man - months. For example, in the case of small-not insured-rice loans, the requirement is 7.85 loan-man-months. (see Table 12).

c. The requirements of collection officers' time are expressed as the difference between expected maturity and actual maturity. In the above case therefore, this requirement is 5.38 man - months (13.20 - 7.85 = 5.35).

When a loan has an expected maturity and/or a collection period of more than 12 months, then the requirements are charged as follows: 12 months are charged in the year when the loan is issued and the remaining is charged in the following or the two following years, if necessary.

d. Loans, bonds, checking and saving accounts require office personnel for administrative purposes in the following way:

	man months
loans	1 man-month per month of actual duration
bonds	0.1 man-month per month of actual duration
checking accounts	3.0 man-month per year
savings accounts	1.5 man-month per year

e. With regard to the risk component, the deviations of loans are modeled in the time year when the loan is collected. For example, if the loan's actual maturity is 9 months, then the MAD's are modeled in the year of issuance. But, if the maturity is 23 months the deviations are modeled in year t+1, as this is the time when returns are collected. Bonds are assumed to be riskless assets.

f. The initial conditions and the repayment of outstanding debts is shown in Table 14. These vectors enter as fixed (with bounds) in all solutions of the model as they reflect obligations acquired previously to period 1.

g. Leverage requirements for all assets and liabilities are calculated according to the criteria in chapter 3. The variable for net worth was approximated by the endogenously generated end of period Net Returns (see the row vector RLE... 1 and the column vector TNR...01).[6]

Table 14. ADBP, Initial Financial Conditions in the Model (million US$).

Item	Year	Loan Recovery	Government Subsidy	Borrowings: Commercial Banks	Borrowings: IDB	Borrowings: World Bank	Borrowings: AID	Borrowings: Other	Total
Sources									
Loan	01	-	-	21.400	5.915	0.780	1.179	2.362	31.636
Amortization	01	23.809	-	-	-	-	-	-	23.809
Interest Collected	01	3.747	-	-	-	-	-	-	3.747
and others	01	-	2.943						2.943
Uses									
Amortization	01			7.133				0.592	7.725
of Borrowings	02			7.133				0.592	7.725
	03			7.133	1.478			0.592	9.203
	04				1.478	0.195		0.592	2.274
	05				1.478	0.195	1.179		2.852
	06				1.478	0.195			1.673
	07					0.195			0.195
Interest Pay-	01			2.568	0.354	.039	0.047	0.118	3.126
ments on	02			1.712	0.354	.039	0.047	0.088	2.240
Borrowings	03			0.856	0.266	.039	0.047	0.059	1.267
	04				0.177	.029	0.047	0.029	0.282
	05				0.088	.019			0.107
	06					.009			0.009
	07					.001			0.001

Source: Tables 10 and 11 and unpublished information.

h. The summary of constraints in year one of the planning horizon included:

number of loans to small farmers	$\geq$ 2000
number of loans to associated producers	$\geq$ 100, $\leq$ 240
number of insurable loans	$\leq$ 2722
value of insurable crop loans (1000 $)	$\leq$ 6806
value of insurable livestock loans (1000 $)	$\leq$ 6307
office personnel (loan man-months)	$\leq$ 116160
loan officers time (loan man-months)	$\leq$ 71520
collection officers time (loan man-months)	$\leq$ 14400

These constraints are assumed to be enlarged during the planning horizon at rates observed in the past. The magnitude of the constraints after year 1 are discussed later on in this chapter.

Risk Measures in the Model

Given the objectives of this research, particular interest was given to measure the risks in the loan portfolio and its impact in managing the bank. Also, given the design of the model, it was necessary to have an account of lending risks in the model's objective function. Therefore, prior to discussing the aggregate structure of the ADBP model, this section explains the measures of risk in the loan portfolio.

Information on loan returns was obtained for seven years (1974-1980) for non-insured loans and for 3 years for insured

loans. The calculations are given in Table A.1 in the appendix. Because the model includes absolute monetary returns and mean absolute deviation of returns the data had to be adapted. This was necessary because for a given loan class (lets say loans of less than $1000, insured for rice) the average disbursed amount was different for every year.

The procedure followed is discussed with reference to Table 15. This is the case of non-insured rice loans of less than $1000. The first seven columns contain information from the survey. The last row provides the column averages. Columns (8) through (11) are calculated as follows.

col (8), the monthly actual rate of interest in year s (s = 1... 7) is computed as:

$$\text{col}(8)_s = \frac{\text{col}(7)/\text{col}(6)}{\text{col}(2)/100}$$

col (9), the actual rate of interest for the average maturity is:

$$\text{col}(9)_s = \text{col}(8) \times \text{col}(\bar{6})$$

where col ($\bar{6}$) is the average actual maturity (average of column (6)) during the observation period (s=7).

col (10), the size adjusted actual loan collection is:

$$\text{col}(10)_s = \text{col}(\bar{2}) \times (1.0 + \text{col}(9)/100)$$

col (11), the deviations from the average size adjusted loan collection is:

Table 15. Risk and Return Characteristics of Rice Loans, not Insured for Small Producers.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Year	Amount Disbursed	Nominal Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Actual Rate of Interest	Actual Rate of Interest for Actual Duration	R_t	d_t
1974	334	8.14	397	12.43	23.57	63.	0.800	10.56	496	8.5
1975	330	8.00	360	7.00	19.00	30	0.478	6.31	528	40.5
1976	445	9.00	461	7.33	17.00	16	0.211	2.78	461	-20.5
1977	457	8.60	478	9.80	9.20	21	0.499	6.59	478	- 9.5
1978	100	9.00	168	6.67	9.66	8	0.517	6.82	479	- 8.5
1979	515	10.00	545	8.50	11.00	30	0.529	6.98	480	- 7.5
1980	900	12.00	919	3.00	3.00	19	0.704	9.29	491	3.5
$\bar{x}$	449	9.25	475	7.82	13.20	27	0.534	7.05	487.5	0.0

Source: Sample of Loans. See Appendix A.

$$col(11)_s = col(\bar{10}) - col(10)_s$$

where $col(\bar{10})$ is the period average size adjusted loan collection:

Therefore, with reference to Table 15 for year 1:

$$\text{Monthly Actual Rate of Interest (8)} = \frac{63.0/23.57}{334.0/100.00} = 0.800\ \%$$

$$\text{Rate of Interest for Actual Diviation (9)} = 0.800 \times 13.2 = 10.56\ \%$$

$$\text{Size Adjusted Actual Collection (10)} = (449)\ (1 + 0.1056) = 496 \text{ US dollars}$$

$$\text{Deviations from Size Adjusted Collection (11)} = 496.0 - 487.5 = 8.5 \text{ US dollars.}$$

The elements in the last colums are the mean absolute deviations introduced in equation (47). These deviations are entered in the model according to the procedures described in chapter 3. The correction factor (Δ) to transform the mean of absolute deviations in a matrix of standard deviations for s=7 is

$$\Delta^{\frac{1}{2}} = \left[\frac{T\ \pi}{2(T-1)}\right]^{\frac{1}{2}} = \left[\frac{(7.0)\ (3.1416)}{2(7-1)}\right]^{\frac{1}{2}} = 1.35$$

which enters the model as shown in Figure 4, $\left[\frac{\Delta^{\frac{1}{2}}}{s}\right]^{-1} = 5.18$.

At this point it should be recalled that according to the discussion in chapter 3, the intertemporal linkage in the risk of return is established through the correlation on bank return between time periods. The correlation of loan recovery between

time periods was calculated equal to 0.303. But since the bank receives yearly subsidies to make up for losses, the total available funds for lending, or in other words the net balance at the beginning of each period, grows more steadily. This is evidenced by the high correlation of total available funds over time which was calculated equal to 0.807. Given that this value is close to 1.00, it was assumed that the standard deviation of returns for the whole planning horizon was equal to the sum of standard deviation of returns of each period in the horizon. Therefore, the model did not have to include intertemporal linkages to measure covariance effects among the matrices of mean absolute deviations.

The Planning Horizon and the Intertemporal Linkages

The model is structured for a 10-year planning horizon. This length was chosen as sufficient to capture the intertemporal linkages of long term loans and borrowings. As discussed in the following section, this length proved to be sufficient for the model results to be consistent. The intertemporal linkages are established through various elements:

i) Loans issued in period t may be collected in periods t+1, t+2, or even t+3, providing returns only at this latter time.

ii) Loans issued in period t would have maturities that imply that they use physical resources in periods t+1, t+2 or even t+3.

iii) Outstanding debts in period 1 ought to be paid back in forthcoming periods, as shown in Table 14.

iv) New borrowings from commercial banks at time t are short term in nature, hence need to be paid in year t + 1.

v) Bonds purchased in period t could mature at the end of period t or in period t+2, hence they use resources during their outstanding period and provide returns only at maturity.

vi) The most important intertemporal linkage is the collected funds in period t that are transferable as disposable funds for period t+1.

Some of these intertemporal linkages can be observed in the picture of the model for the first two planning periods, shown in Figure 6. A similar linkage exists for subsequent time periods.

Some assumptions were necessary about the rate of growth of specific parameters. As far as resource availability, it was assumed consistently with previous experience, that office staff, loan officers, collection officers and vehicles will grow at a rate of five percent per annum. About the insurance program, ISA has indicated its willingness to increase the coverage to crops and livestock at a rate of 10 percent per

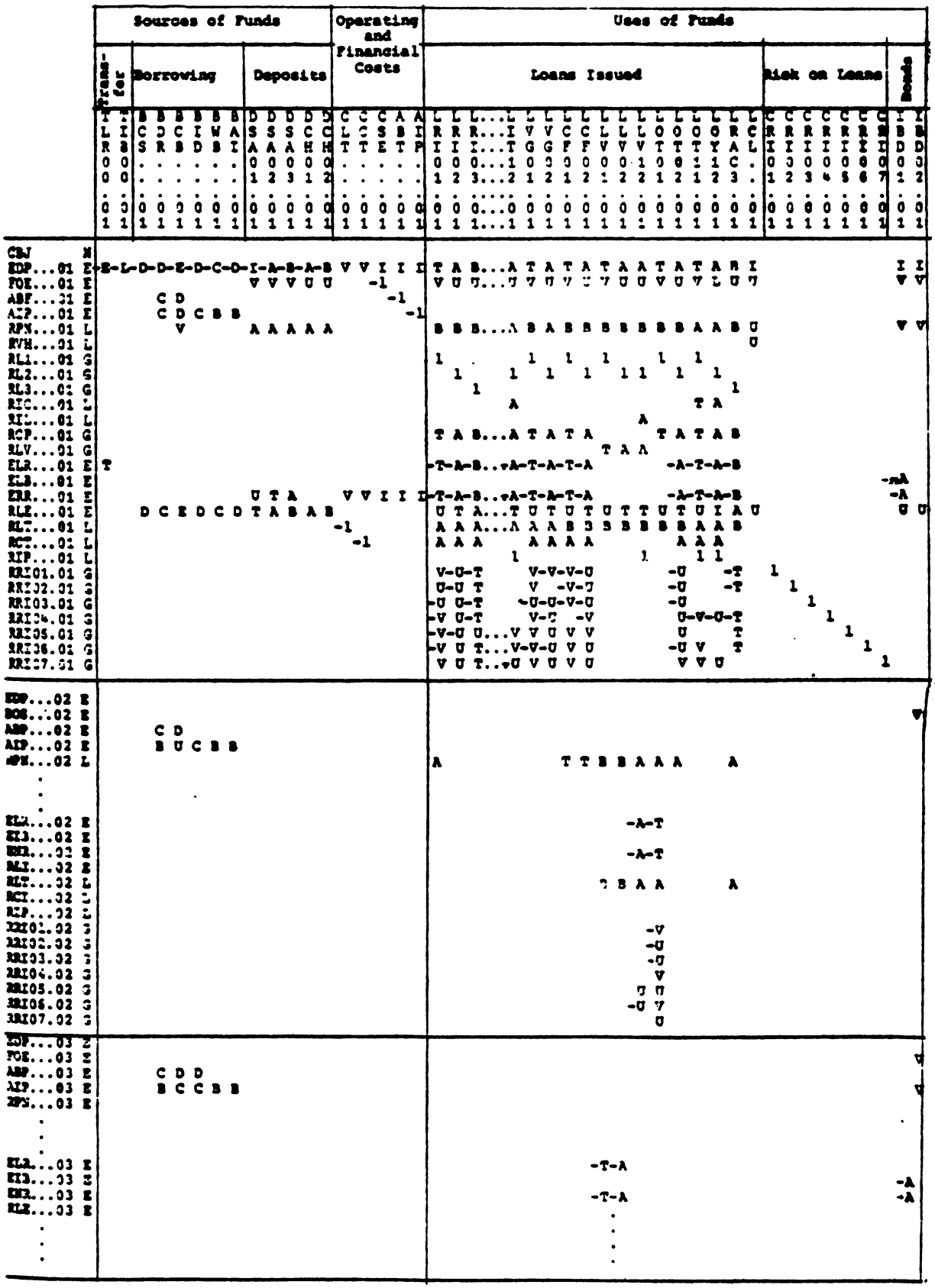

Figure 6. Sample of Vectors of the Model Showing Intertemporal Linkages.

annum. But being aware of high administrative costs, ISA would prefer to concentrate on medium size policies, hence it was assumed that the total number of policies would grow only at five percent per year. It is also assumed that the bank's policy is to continue servicing the smaller farmers, hence the number of loans to small farmers would also grow at an annual rate of 5 percent.

It is recognized that these assumptions would influence the allocation of funds among the many alternatives, yet they may be preferable to an assumption of no change in these parameters. These growth rates are likely to be influenced by the government allocation of funds for development purposes. However, it is assumed that direct government subsidies to the bank will be maintained constant at 3 million US$ per year. Any changes in these assumptions are perfectly feasible as the bank authorities or the government enforce new policies.

Validation of the Model

Introduction

A mathematical model is an abstraction of reality. Nevertheless, the structure and the data used should allow one to reproduce the real conditions with the highest approximation. On the other hand, in the context of the mathematical programming model used, one could impose all possible restrictions and hence reproduce lending and borrowing plans and levels of resource

use that exactly resemble the current allocative criteria of the bank. Such a solution from the model could be far from the economic optimum as the levels of each vector are determined a priori. For example the bank may decide the amount to be allocated to each crop, independently of any financial or economic criteria.

The model used here included some of the most important financial, physical and institutional constraints, but the decisions on lending and borrowing, and hence the levels of resource use are endogenously determined. Therefore, a basic solution of the model approximates reality, but by no means could it resemble the actual disagregated portfolio of the bank. With this caveat, it is understood that the solutions of the model provide insight about the possible effects of modifying alternative scenarios. The solutions however, should not be taken literally as a 'crystal ball' prediction.

Before using the model for policy analysis, it was tested in terms the appropriateness of the planning horizon and its response to the discount rate. The first test was performed to evaluate whether the planning horizon is long enough for the first years' solutions to be stable. The second test was necessary to determine the importance of the discount rate in the allocation of funds over time.

The Appropriateness of the Planning Horizon

The model was solved first for a planning horizon of 10 years and this is called the Basic Solution. To test the stability of the solutions in the first and second years, an eleventh year was added to the model. The linkages between years 10 and 11 follow exactly the same approach as for earlier periods.

Tables 16 and 17 give the main results of the model for the Basic Solution and for the one with 11 years. As expected, the model's objective function and the standard deviation of returns increase. The important result is that the solution of the model for the first two years did not change in terms of the composition of the loan portfolio, the transfer of funds and the borrowings from commercial banks. In fact small changes began only in the fourth period and they become more significant towards the seventh period.

The above will confirm the proposal that a ten year planning horizon is sufficient if the major interest is in analyzing the impact of policies over the first two or three years of the model. However, the above assumes that the policies evaluated do not imply consideration of assets and liabilities of longer maturities. With this limitation it could be assumed that with a 10 year model, the bank can evaluate the impact of some policies four or five years ahead of the current period.

Table 16. ADBP Model, Test of the Length of the Planning Horizon (million US$).

Variable	Year	Length of Planning Horizon 10 years	11 years
Objective Function		226.117	257.237
Standard Deviation of Returns		3.101	3.532
Transfer of Funds	01-02	51.014	51.014
	02-03	34.078	34.078
	03-04	41.348	41.379
	04-05	58.192	58.293
	05-06	59.332	59.672
	06-07	63.051	64.001
	07-08	67.146	68.137
	08-09	69.828	70.172
	09-10	95.091	72.624
	10-11	-	98.137
Total Lending	01	49.792	49.792
	02	48.937	48.937
	03	30.956	31.052
	04	45.318	45.478
	05	56.201	56.834
	06	59.695	50.837
	07	63.530	65.532
	08	66.198	67.137
	09	87.259	69.930
	10	40.742	88.038
	11	-	41.737

Table 17. ADBP Model, Portfolio Composition in Years 1 and 2 with 10 and 11 years Planning Horizon (Number of Loans).

	Length of Planning Horizon	
	10 years	11 years
Year 1		
Rice, not insured, large producers RI03	1766.12	1766.12
Rice, Insured, large producers RI13	267.92	267.92
Rice, insured small producers RI11	2000.00	2000.00
Livestock, not insured medium producers LV02	202.27	202.27
Rice Associated not insured RA03	100.00	100.00
Year 2		
Rice, not insured large producers RI03	959.79	959.79
Rice, insured small producers RI11	1493.04	1493.04
Industrial tomatoes not insured, medium producers IT02	1261.81	1261.81
Vegetables, not insured, small producers VG01	606.96	606.96
Livestock, not insured medium producers LV02	2245.89	2245.89
Livestock, insured medium producers LV12	1446.96	1446.96
Rice associated, not insured RA03	240.00	240.00

Sensitivity to the Discount Rate

There is not perfect certainty about the correct discount rate to be used. In the case of a public bank, where profits are not distributed at the end of each period, the discount rate could be ignored. However, as this general model is applicable to banks with different proportions of public and private ownership, the rate of discount was changed from 5 to 10 percent to test the sensitivity of the model. The corresponding discount factors are given in Table 18.

The expected effect of an increase in the discount rate, if profits were distributed at the end of each year, will be a preference for earlier returns. The above would be obtained if the bank increased the issuance of short term loans, hence it would collect the money earlier. Also, as insured loans in general have shorter maturities, one would expect a preference for insuring a larger proportion of the portfolio. The latter would not necessarily imply a larger number of insured loans, but a larger volume of insured credit.

The data in Table 19 and Figure 7 show that as the discount rate increases, the bank tries to lend more in the earlier periods to get money back earlier. In fact, at a discount rate of 5 percent, by year 4 the bank would have loaned 31.89 percent of the total; but at a rate of 10 percent, by year 4 the bank would have loaned 33.71 percent, a slight increase over the

Table 18. Discount Factor for Each Year of the Planning Horizon at Discount Rates of 5 and 10 Percent.

Year	5%	10%
1	.952	.909
2	.907	.826
3	.863	.751
4	.822	.683
5	.783	.620
6	.746	.564
7	.710	.513
8	.676	.466
9	.644	.424
10	.614	.385
11	.584	.350

Source: Gittinger, J.P. Compounding and Discounting Tables, John Hopkins University Press, Baltimore, 1973.

Table 19. ADBP Model, Sensitivity of Lending and Transfer of Funds to the Discount Rate (million US$).

Variable	Year	discount rate (%) 5	10
Objective		226.17	178.732
Standard Deviation		3.101	3.067
Transfer of Funds	01-02	51.014	51.016
	02-03	34.078[a]	37.777[a]
	03-04	41.348	42.904
	04-05	58.192	57.402
	05-06	59.332	58.567
	06-07	63.051	62.309
	07-08	67.146	66.428
	08-09	69.828	69.134
	09-10	95.091	94.371
	Total	539.080	539.904
Loan Issuance	01	49.792	49.794
	02	48.937	50.407
	03	30.956[a]	32.135[a]
	04	45.318	47.183
	05	56.201	55.465
	06	59.695	58.982
	07	63.530	62.851
	08	66.198	65.355
	09	87.259	89.498
	10	40.742	20.834
	Total	548.628	532.504

[a]The drop in availability of funds at the end of year two is due to the commitments of the bank and the insufficient government subsidy built in the model. This also determines the rather small loan issuance in year three.

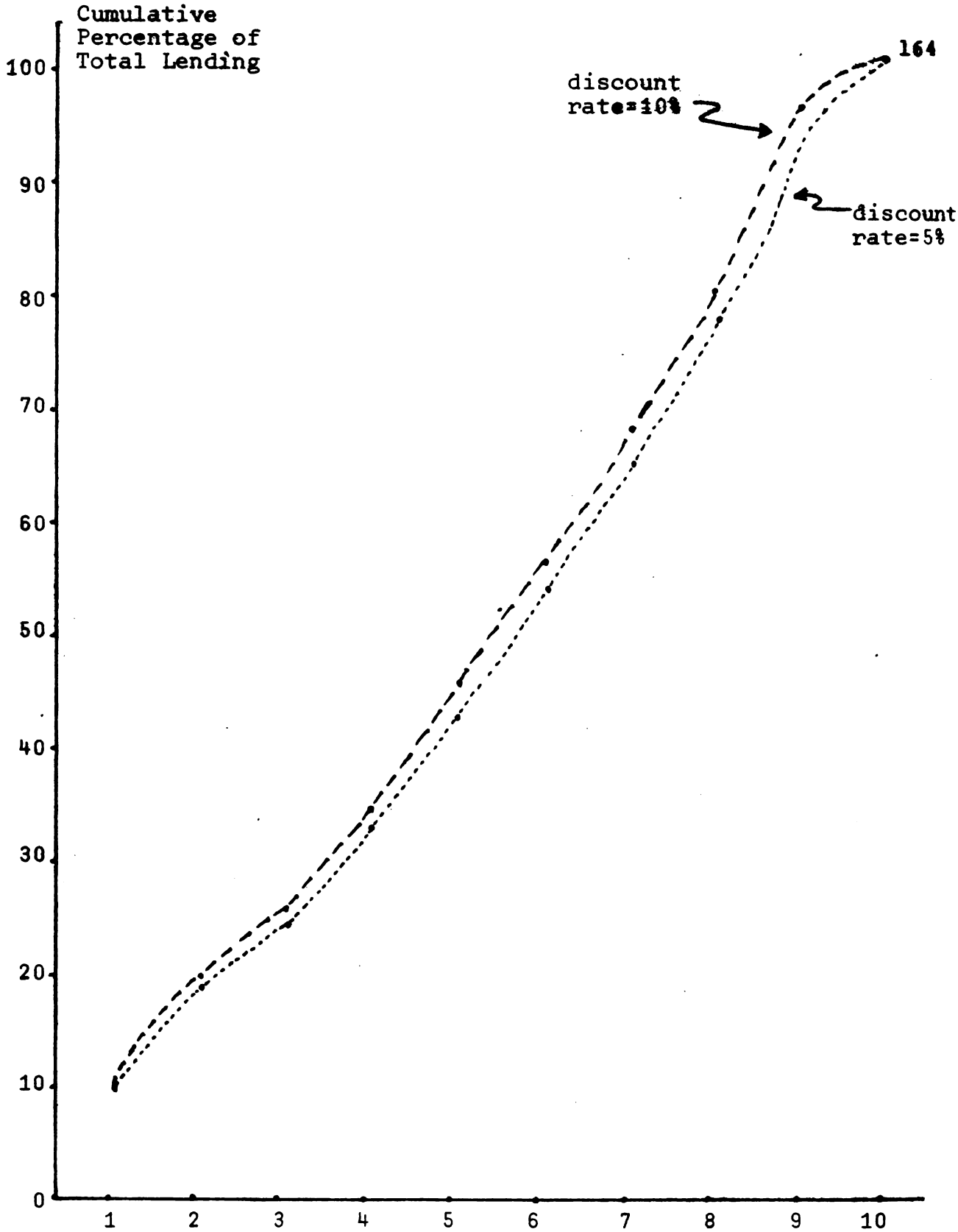

Figure 7. ADBP Model, Distribution of Cumulative Lending at Different Discount Rates.

earlier figure. Stronger adjustments are inhibited by resource availability and leverage requirements.

Since livestock loans have longer maturities than crop loans, the first will decline in the first years as the discount rate increases, as shown in Table 20. However, because the number of insurable loans reaches the upper limits, the volume of non-insured credit in the first years increases. As non-insured credit is now a larger proportion of the portfolio the amount of physical resources used by the bank increases in comparison to the situation with a lower discount rate.

The importance of the discount rate is clear, yet a careful analysis must be made of this parameter to determine the value that should be used. The above will be necessary particularly for a private bank. In the following analysis, the discount rate was maintained at the original level of 5 percent.

Table 20. ADBP Model, Maturity Structure of Loans and Preference for Insurance at Different Discount Rates in Years 1 to 4 (million US$).

Variable	Year	discount rate (%) 5	10
Volume of Credit in Loans of Less than one year	1	48.986	48.986
	2	32.697	36.558
	3	30.956	32.135
	4	36.493	38.369
Volume of Credit in Loans of More than one year	1	0.806	0.806
	2	16.240	13.849
	3	0.000	0.000
	4	8.814	8.814
Volume of Insured Credit	1	7.146	7.146
	2	8.163	8.163
	3	8.647	8.647
	4	18.335	18.335
Volume of not Insured Credit	1	42.646	42.646
	2	40.774	42.244
	3	22.309	23.488
	4	26.972	28.848

End Notes

[1]ISA also insures the investment of farmers without official credit.

[2]ANAGSA is the government owned and highly subsidized agricultural insurer, which serves primarily small and "ejido" farmers. SAM stands for the Mexican Food System.

[3]This is to say that the small loan requirements will be met by issuing non-insured loans for all crops and livestock and insured loans for rice, corn, industrial tomatoes, and for other loans (see Table 12).

[4]These vectors are included only in year 1. A coding for the rows and columns is presented in Appendix B.

[5]The version of MPSX used (in an IBM/360-40 machine) did not include a report generator. Advanced versions of MPSX/370 that can be used in equipment of greater capacity do include report generators.

[6]Leverage requirements were used at the same levels recommended by the U.S. Examinors Criteria discussed in Chapter 3. Information on this issue was not available in Panama.

CHAPTER V

POLICY ANALYSIS AND GROWTH PERSPECTIVES

The Approach to Policy Analysis

The results of the model are a guide to the expected effects of various changes in policy. Therefore, the model does not produce a solution to the problems, but only an indication of how to go about solving such problems. This is facilitated by the information generated in each solution for all variables in the model. This chapter discussed the main results of a series of important changes in strategy and policies. These changes are compared with the basic solution of the model and with other solutions in order to highlight the main findings.

Since the model has 298 equations and 513 activities, the information provided is extremely detailed. This information is contained in the activity levels and shadow prices or opportunity costs of each row and column vectors. However, only a few variables have been selected for discussion purposes. The emphasis on a particular variable or group of variables changes depending upon the type of policy under consideration.

It is conventient to recognize the scenarios for policy analysis. In principle there is only one version of the model which is resolved under alternative assumptions. The first

three analyses involving credit insurance, the cost of serving small farmers and the higher cost of funds were made under the current organization and financial structure of the ADBP i.e., without savings and checking accounts and without possibilities for investment in the bond and security markets. The fourth analysis was done after relaxing the above conditions, assuming that the bank would fulfill multiple functions.

In summary a total of 10 possible scenarios were simulated through changes in important parameters. These were:

A.1 The basic solution; in which it was assumed that the ADBP operated under neutral attitudes towards risk (ϕ=0) and with the physical, financial and istitutional constraints at the levels discussed in chapter IV.

A.2 It was assumed extreme risk aversion (ϕ=-3.15) with the same constraints as in A.1.

A.3 It was assumed a neutral attitude towards risk (ϕ=0), without participation in the agricultural credit insurance program.

A.4 It was assumed extreme risk aversion (ϕ=-3.15) and also without participation in the agricultural credit insurance program.

A.5 It was assumed the same conditions as in A.1 but without a requirement for making small loans.

A.6 It was assumed the same conditions as in A.5 but with an increased cost of borrowed funds from commercial banks from 6.0 to 8.0 percent annual rate of interest.

A.7 It was assumed that besides a higher cost of funds (A.6) the bank will operate without government subsidy.

B.1 In this case the bank was assumed to have the opportunity for investment on bonds and issuance of checking and saving accounts, with all other conditions as in the case of A.7.

B.2 It was assumed that the bank also had investment opportunities like in B.1 but with an increase in the annual interest rate on borrowed funds from 8.0 to 10.0 percent.

B.3 It was assumed that besides a higher cost of funds like in B.2 the bank will increase the interest rate on loans by 2 percent.

The above solutions were chosen for discussion purposes and to illustrate the usefulness of the model in evaluating an alternative hypothesis. Many other solutions are possible under alternative scenarios.

Development Banking and Credit Insurance

Bank Attitudes Towards Risk and Credit Insurance

Decision makers in general show varying degrees of risk aversion in the sense that they have different preferences for return relative to the variance of return. Bankers are no exception, although the type of bank ownership will influence the attitude towards risk. It is assumed that public institutions are less concerned with risk management, as any significant losses can be recovered through government allocations. In addition, public institutions have been able to reduce financial risks by obtaining low-cost long-maturity funds from international financial agencies. Private lenders are likely to be more concerned with risks because they do not have access to free government funds and because they borrow almost exclusively in the commercial capital market.

The purpose of this section is to illustrate how credit insurance benefits a bank serving the agricultural sector, even when there is a neutral attitude towards risk. To start, we should recall the hypothesis (p. 53) that credit insurance has three effects, first it improves average loan recovery, second it reduces risk of returns, and third it diminishes administrative costs.

The first two columns in Table 21 show the growth of transfer of funds (Net loan recovery), lending and borrowing,

when the number of insurable loans is assumed to grow at an annual rate of 5 percent per year. Column 1 shows the results when the bank is risk neutral (ϕ=0) and column 2 shows the results when the bank is extremely risk averse (ϕ=-3.15). The expected growth paths for a bank operating under a risk neutral (ϕ=0) or an extreme risk averse (ϕ=-3.15) type of management were found to be very similar. However, when the bank acted under a risk averse manner, the path of growth was slightly more stable but with a smaller total utility over the planning horizon.

The above suggests that the variance of returns in the loan portfolio is rather small and hence there would not be a significant change in the allocation of funds as the degree of risk aversion increases. This condition in turn implies that average recovery is the determinant factor for choosing among various types of loans. It is interesting that in spite of this situation, the model shows important benefits to the ADBP from insurance. Even without risk aversion (column 3 in Table 21) the absence of this insurance program would have implied a much slower growth for the bank.

When insurance is not available, loan recovery declines; therefore, given the bank's leverage requirements, borrowings from commercial banks also decline but not as much. The net effect is a decline in lending activity as the net transfer of

Table 21. ADBP Model, Growth with and without Insurance (million US$)

Variable	Year	Situation			
		With insurance		Without insurance	
		risk neutral	risk averse	risk neutral	risk averse
Objective Function	10 years	226.117	214.215	196.424	181.919
Transfer of Funds	01-02	51.014	51.014	51.161	51.169
	02-03	34.078	37.777	22.353	33.930
	03-04	41.348	42.904	38.725	43.591
	04-05	58.192	57.402	53.107	50.633
	05-06	59.332	58.567	53.308	50.913
	06-07	63.051	62.309	56.031	53.708
	07-08	67.146	66.434	58.986	56.758
	08-09	69.828	69.022	61.698	59.190
	09-10	95.091	90.801	66.334	63.557
Total Lending	01	49.792	49.792	49.603	49.629
	02	48.937	50.407	37.941	42.541
	03	30.956	32.135	36.510	40.199
	04	45.318	47.183	32.904	38.773
	05	56.201	55.461	51.175	48.873
	06	59.695	58.981	53.789	51.559
	07	63.530	62.857	56.628	54.488
	08	66.198	65.247	59.233	56.824
	09	87.259	85.966	63.686	60.902
	10	40.742	40.067	35.702	34.221
Borrowings from Commercial Banks	01	21.400	21.400	21.400	21.400
	02	9.904	11.710	0.413	6.065
	03	16.065	15.524	23.115	21.420
	04	22.379	22.050	20.498	19.468
	05	23.867	23.548	21.630	20.638
	06	26.680	26.370	24.066	23.099
	07	28.544	28.252	25.460	24.544
	08	28.894	28.500	26.510	25.287
	09	50.993	48.351	29.476	28.089
Standard deviation of Returns		3.101	2.988	4.264	3.924
Solution		A.1	A.2	A.3	A.4

funds between periods also diminishes, as it is illustrated in Figure 8 for the risk neutral case with and without insurance.

There is a clear indication that insurance has a net positive effect on bank growth. This net effect is however, the result of a number of forces. The availability of insurance, even when it is only for a portion of the total loan portfolio, allows for a larger number of medium size loans, which are also of shorter actual maturity than large loans. Hence, money is turned around more rapidly. In addition, as shown in Table 22, the expenditures on loan supervision and collection, as a proportion of total expenditures, is reduced considerably; therefore, leaving a larger availability of loanable funds. It should be observed in Table 22 that even when the total volume of loans issued declines when insurance is not available, the collection costs increase considerably as the number of overdue loans grows.

The opportunity cost of a restriction on the number of insurance policies declines over time because of the assumed growth rate of ISA's program (see Table 23). In spite of this latter assumption, all shadow prices suggest that it would pay to supply ISA with additional operating resources to issue a larger number of policies. For example one additional insurance policy in year two would increase the utility of the risk neutral bank by U.S. $5,190 over the 10 year horizon.

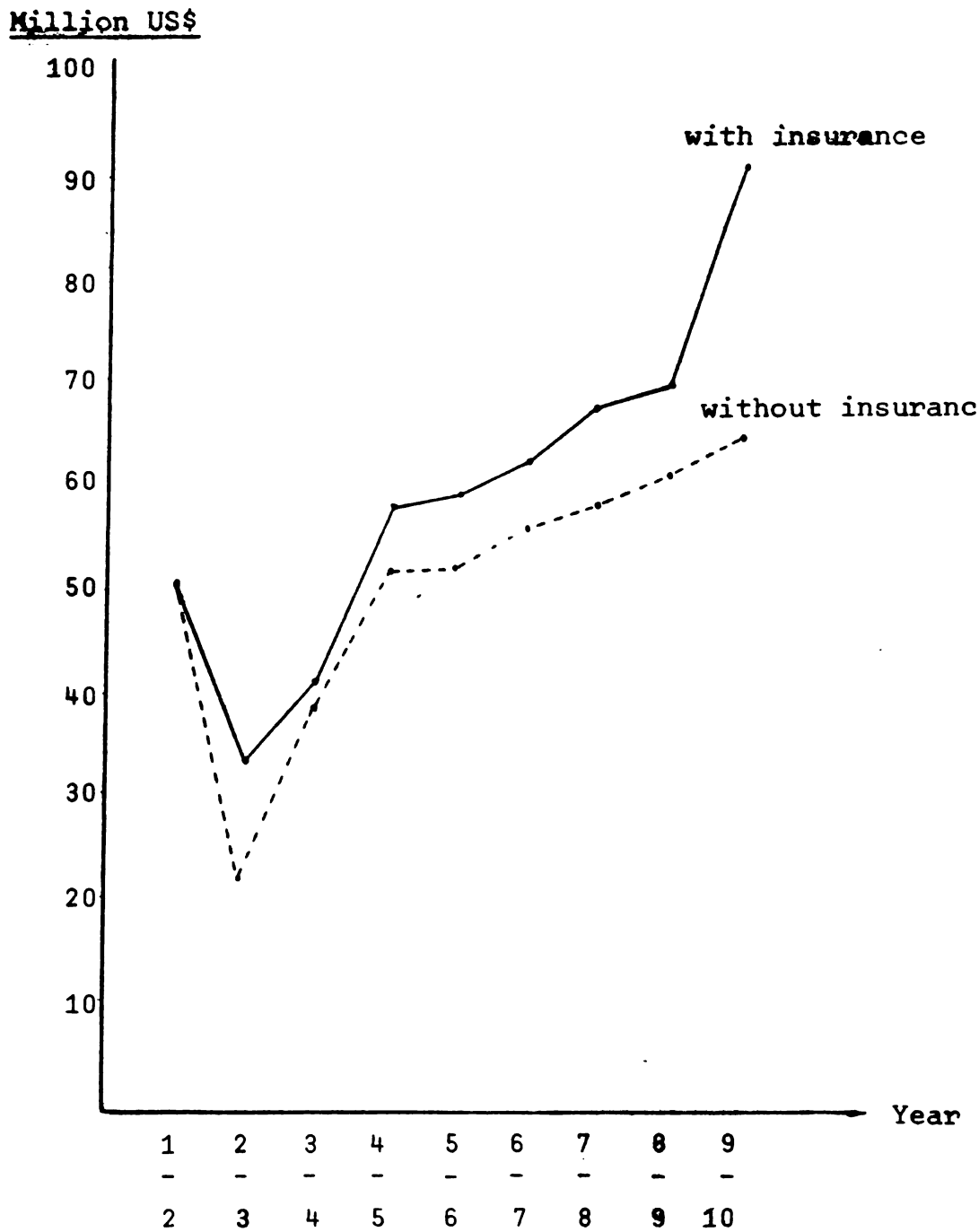

Figure 8. ADBP Model, Transfer of Funds Between Periods, Risk Neutral Case.

Table 22. ADBP Model, Personnel Costs with and without Insurance (10 years)1/.

Variable	Risk Neutral Situation with insurance	Risk Neutral Situation without insurance
Total Costs (million US$)		
Loan Officer Time	60.958	49.366
Collection Officer Time	13.010	17.905
Total	73.968	67.271
Average Cost per Loan (US$/Loan)		
Loan Officer Time	14.50	16.90
Collection Officer Time	3.10	6.20
Solution	A.1	A.3

1/ Does not include all other fixed costs.

The ADBP model results in Table 24 show a definite bank preference for insuring loans for rice and livestock. Arcia (1982) reports that these two items are the ones in which ISA has the lowest administrative costs. These items also dominate ISA portfolio as described in Arcia's model. It is surprising, however that the bank model does not show a preference for insuring loans for corn and sorghum, the items in which ISA has had the largest losses. The reason may be that, besides being very risky, loans for corn and sorghum are unprofitable for the bank in terms of average recovery. Similarly, loans for industrial tomatoes appear more attractive because of large returns, but these loans tend to be rather small and therefore, from a resource use point of view, loans for tomato production are not appealing to the bank.

The adjustment on the bank portfolio over time for the basic solution, is illustrated in Figure 9. It is evidenced that the bank changes the overall composition of its total portfolio very little, with rice being always the dominant item.

Bank Opportunity Cost of Serving Small Farmers

As it was discussed in chapter 2, ADBs and their financial policies for agriculture have been severely questioned. On the other hand, within the existing structure of the agricultural sector in developing countries, ADBs play an important role by

Table 23. ADBP Model, Total Number of Loans Issued and Opportunity Costs of Insurance (10 years).

Variable	with insurance risk neutral/risk averse		without insurance risk neutral/risk averse	
By Size				
Small[a]	25156	25156	25156	25156
Medium	18663	22878	7051	8966
Large	18331	18161	19127	26063
Total	62150	66195	51334	60185
Insured Loans	33566	33566	0	0
Shadow prices of the number of Insurance Policies (1000US$/policy				
1	0.000	0.000	-	-
2	5.190	4.748	-	-
3	0.000	0.000	-	-
4	0.316	0.291	-	-
5	0.273	0.240	-	-
6	0.233	0.202	-	-
7	0.194	0.166	-	-
8	0.155	0.130	-	-
9	0.118	0.133	-	-
10	0.000	0.000	-	-
Solution	A.1	A.2	A.3	A.4

[a]The number of small loans was always equal to the minimum requirement i.e. 2000 loans in the first year and a growth rate of 5 percent per year.

Table 24. Comparison of the ADBP and ISA Insurance Preferences.

Variable	Total	Insured Items: Rice	Corn Sorghum	Industrial Tomatoes	Livestock	Other
Actual ISA's[a] coverage (million $)	13.118	3.340	2.116	1.289	6.329	0.044
ISA's administrative[a] Costs as a percentage of coverage	-	2.54	8.96	11.59	3.70	11.68
ISA's coverage in[a] Arcia's Model ($)	13.118	3.725	1.574	1.181	6.559	0.079
	100.0	28.4	12.0	9.0	50.0	0.6
ISA's Coverage in[b] the ADBP Model ($)	14.133	6.849	-	-	7.284	-
Basic solution for[b] year 2 (%)	100.0	48.5	-	-	51.5	-

Sources: [a] Arcia, (1982)

[b] Results from the ADBP model

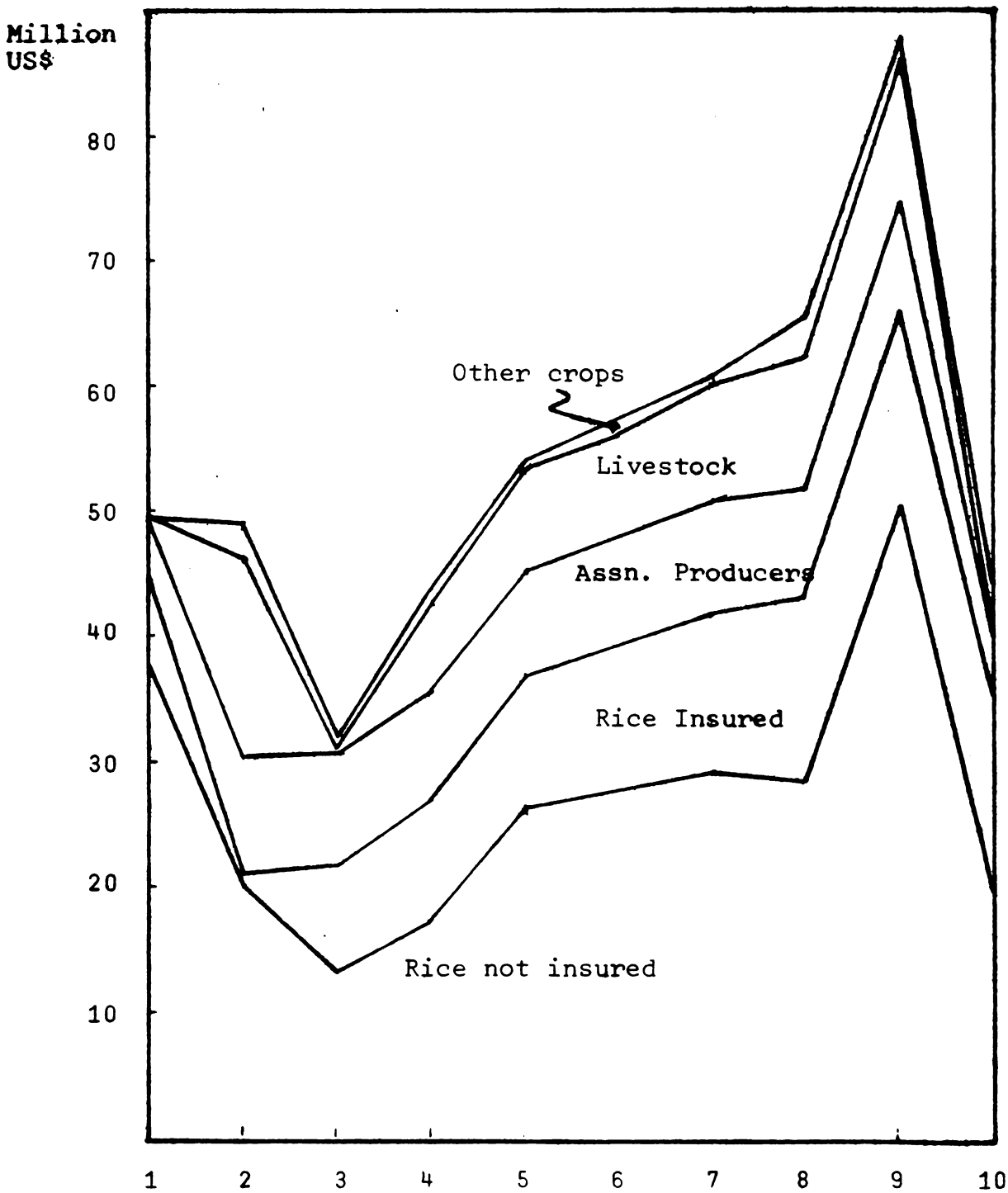

Figure 9. ADBP Model, Intertemporal Composition of the Loan Portfolio, 10 years.

providing low interest credit to small farmers. These financial resources would not likely be provided by profit oriented commercial banks, for whom the administration costs are too high; hence the political justification of development banks.

Although much has been written on this issue, no empirical study has measured the opportunity costs of serving small farmers. To illustrate opportunity to the bank of providing these benefits, this section uses results of the ADBP model. The analysis is based on a comparison of growth paths, loan issuance and net utility in the basic model solution with the one in which we eliminate the requirement of a minimum number of small loans.

Small loans are, in general, not more risky than large loans neither do they have lower average rates of return. The reason the bank rejects them stems from their relatively high cost per dollar lent. Because of the latter profit oriented institutions such as commercial banks would prefer not to issue small loans. However, if important risk differences were to exist between small and large loans; small loans may become more desirable for a risk averse institution. As shown in Table 25, demanding the issuance of small loans has a negative impact on the bank's total utility, which diminished by approximately 10 percent. Operating costs, particularly the cost of loan officers and collection officers'

Table 25. ADBP Model, Growth with and without Constraint on Small Loans (million US$).

Variable	Year	Basic	without restriction on small loans
Objective Function		219,919	241,372
Transfer of Funds	01-02	51.014	50.934
	02-03	34.078	34.669
	03-04	41.348	44.206
	04-05	58.192	63.079
	05-06	59.332	64.464
	06-07	63.062	68.454
	07-08	67.135	72.835
	08-09	70.012	76.049
	09-10	92.042	98.331
Total Lending	01	49.792	49.981
	02	48.937	51.271
	03	30.956	33.477
	04	45.318	47.988
	05	56.201	61.127
	06	59.695	64.883
	07	63.530	69.007
	08	66.198	72.000
	09	87.259	93.305
	10	40.742	43.966
Borrowings from Commercial Banks	01	21.400	21.400
	02	9.904	10.230
	03	16.065	18.333
	04	22.379	24.600
	05	23.867	26.207
	06	26.680	29.150
	07	28.534	31.147
	08	29.071	31.850
Standard deviation		3,213	3,558

time will be the determinant factor of lower total utility. Table 26 illustrates that with the requirement of issuance of small loans, total loan officer and collection officer time increase by million U.S $15.64. Total utility declines by million U.S. $21.45.

In this study the benefit can only be measured in terms of the number of beneficiaries of this policy.[1] As shown in Table 27, assuming an elastic demand for small loans 30 percent more farmers would have received credit, and the average loan size would be US$8900 as compared with an average loan size of $14500 when small loans were not required.

The bank is able to grow at a faster rate when small loans are not required because operating costs are reduced and funds are release for loan issuance. When small loans are not obligatory, the bank would not issue any of them and the demand for loan officers' time would decline by 14 percent, and the demand for collection officers' time by over 50 percent. This reduction in collection officers' time contrasts significantly with the situation when the insurance program was eliminated (Table 22).

It should also be noted that without small loan requirements, the insurance program makes a more valuable contribution to the bank as larger loans are riskier. However, when the bank does not issue small loans the insurance portfolio is composed

Table 26. ADBP Model, Personnel Costs with and without Restriction on Small Loans (million US$).

Variable	Year	Basic	without restriction on small loans
Loan Officer Time	01	2.866	2,160
	02	7,509	7,509
	03	5.335	5,189
	04	6.712	6.088
	05	5.855	4.815
	06	6.325	5.205
	07	6.839	5,634
	08	7.343	6,046
	09	8.601	7,201
	10	3.573	2.523
	Total	60.958	52.370
Collection Officer Time	01	0.579	0.579
	02	1.512	1.512
	03	0.214	0.253
	04	0.945	0.326
	05	1.177	0.496
	06	1.305	0.524
	07	1.446	0.554
	08	1.581	0.564
	09	2.001	0,844
	10	1.250	0,299
	Total	13.010	5,951
Solution		A.1	A.5

Table 27. ADBP Model, Number of Loans and Average Size of Loans with and without Constraints on Small Loans.

Variable	Year	Basic	without constraints on small loans
Number of Loans	01	4336	2434
	02	8253	7254 [a]
	03	3403	1373 [b,d]
	04	5519	3387
	05	6270	4127
	06	6697	4447
	07	7159	4798
	08	7591	5113
	09	8897	6292
	10	4721	1847 [c]
	Total	62846	41072
Size of Loan (1000 $)	01	6.825	20.531
	02	5.930	7.067 [a]
	03	9.096	24.383 [b,d]
	04	8.221	14.168
	05	8.964	14.814
	06	8.913	14.592
	07	8.879	14.381
	08	8.720	14.080
	09	9.807	14.829
	10	8.621	43.966
Solution		A.1	A.5

[a] mostly medium size loans

[b] only large loans

[c] only crop loans, because livestock loans have longer maturities.

[d] It should be recalled that the shortage of funds at the end of years one and two and the financial commitments in year 3 force the bank into the most constrained allocation of funds hence in year 3 it issues primarily large loans.

Table 28. ADBP Model, Shadow Prices of the Restriction on Small Loans and Cooperative Loans.

Year	Small Loans 1000 $/Loan	Cooperative Loans 1000 $/Loan
01	0.163	- 0.928 LL (gain) [a]
02	7.809[c]	5.279 UL (loss) [b,c]
03	0.279	.762 UL
04	0.554	.693 UL
05	0.472	.585 UL
06	0.399	.490 UL
07	0.328	.393 UL
08	0.259	.298 UL
09	0.192	.206 UL
10	0.056	.125 UL

[a] lower limit ($\geq$100 loans)

[b] upper limit ($\leq$240 loans)

[c] The shortage of funds in year two makes the restriction on the number of small loans very severe. Similar interpretation is possible for the upper limit on the maximum number of very (large) cooperative loans.

of a smaller number of medium and large policies. Therefore the restriction on the number of insurance policies in the bank model is not effective, implying that the insurance portfolio could be administered at a lower average cost.

An indication that small loans on the aggregate are less risky is suggested by the smaller standard deviation of the bank portfolio, shown in the last row of Table 25. This is noticeable even when the insurance program was in operation which could suggest that without insurance, the risk of lending to large farmers is even greater than what the results in Table 25 suggest.

It is evident that requiring the issuance of small loans has some impact on slowing bank growth. Nevertheless, because small loans have expected returns that are in relative terms greater than for large loans, their average actual duration is shorter and they are less risky, their imposition on the bank's portfolio does not imply such a signficiant cost in financial terms.

While this particular case is instructive, caution should be exercised not to attempt to generalize this data to other ADBs. Nevertheless, it suggests that agricultural development banking may not impose a very severe burden in terms of the opportunity cost of funds. Furthermore, it should be kept

in mind that the proportion of small loans used for agricultural production, is usually greater than that of large loans. This is because the diversion of low interest credit outside agriculture is more common among large farmers with other investment alternatives besides agriculture (Gonzalez Vega, 1977; Adams, 1981).

Financial Stress and the Alternative of Diversified Banking

Higher cost of funds and more constrained government subsidies may affect the feasibility of development banking with preferential rates to the agricultural sector. A higher proportion of funds are being acquired at commercial rates, thanks to government subsidies. But as the latter dry out the banks may not have other alternatives than diversification of sources and uses of funds and the use of higher interest rates on loans.

Higher interest rates on loans are largely advocated, yet it is possible that this policy may lead to higher rates of default. Because this information is not available it was was assumed that the rates of default would not change for small increases in interest rates. An analysis was also made of higher interest rates and the elimination of government subsidies and their impact on bank borrowing and growth.

The Cost and Availability of Funds and the Impact on Growth

An increase in the cost of funds reduces the bank's rate of growth. Figure 10 illustrates that an increase in the cost of funds from commercial banks, from 6 to 8 percent, slows the bank's growth. The rate of growth is reduced even further when the bank does not receive the US$3 million/year in government subsidies. In this latter case it is possible to observe a decline in total lending after the fifth year, recovering only in year nine. It is evident that a specialized ADB could not grow without government subsidies, particularly when funds from international development agencies dry out.

When the cost of funds increased, the bank adjusted its asset and liability portfolios. Table 30 shows that borrowings from CBs declined by 11.5 percent while the amortization of interest payments increased by 8.0 percent. On a percentage basis there was not a significant change in the source of funds. However, in the use of funds, interest payments by the bank increased from 3.64 percent to 4.31 percent, while loan issuance declined from 62.44 percent to 61.82 percent. It was observed that the size of the bank's portfolio declined, because of a reduction in loan issuance.

The elimination of government subsidies caused a more dramatic change in the structure of the bank than did an increase in the cost of funds. The size of the bank declined

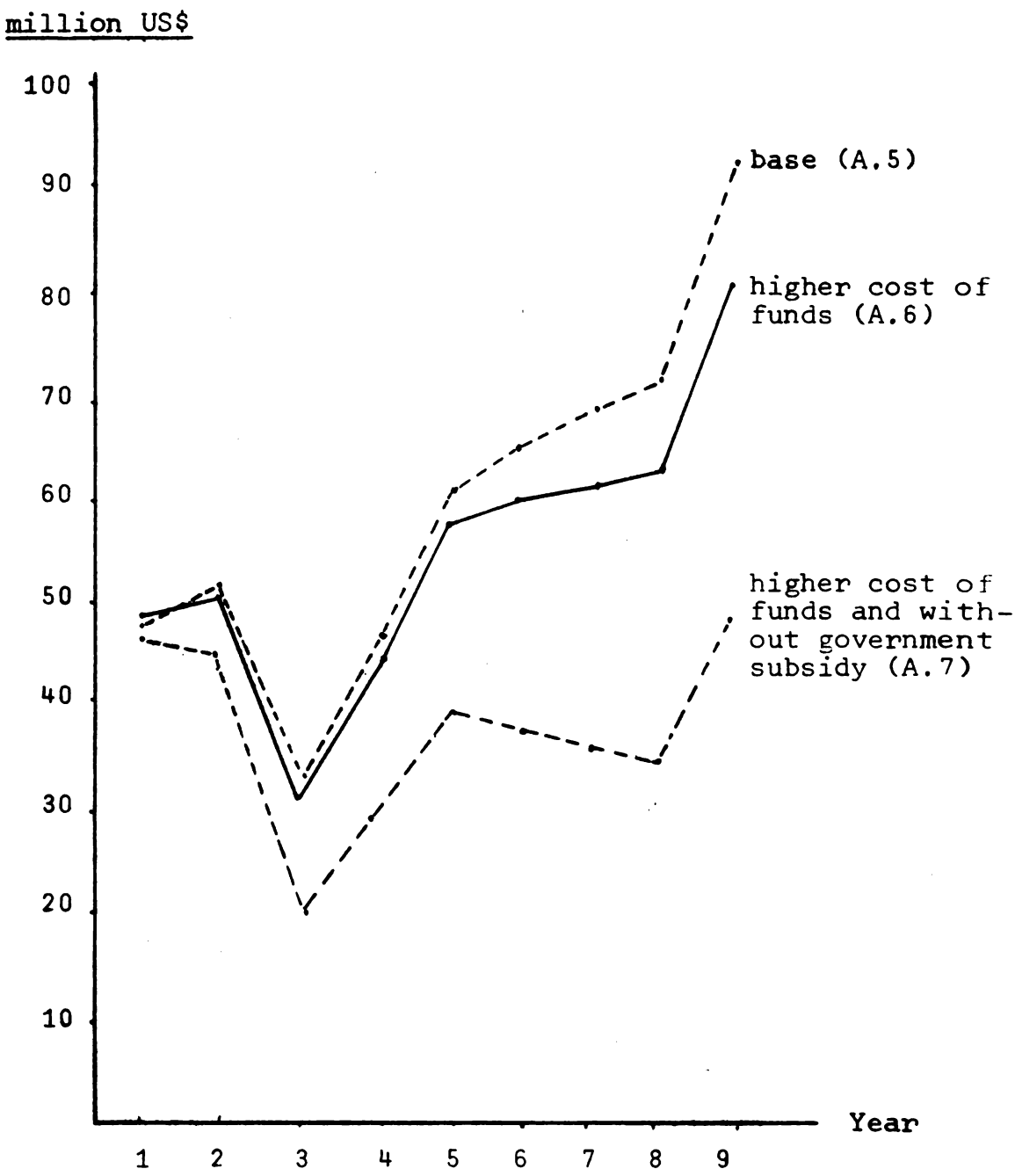

Figure 10. Comparative Growth Paths for Total Lending with Higher Cost of Funds and without Government Subsidy.

Table 29. ADBP Model, Growth with Higher Cost of Funds and Without Government Subsidy

Variable	Year	without restriction on small loans	with higher cost of funds	with higher cost of funds and without government subsidy
Objective Function		241.372	219.800	145.737
Transfer of Funds	00-01			
	01-02	50.934	50.934	47.684
	02-03	34.669	34.059	26.267
	03-04	44.206	42.570	30.847
	04-05	63.079	60.076	44.473
	05-06	64.464	60.024	40.312
	06-07	68.454	62.477	38.886
	07-08	72.835	65.273	38.009
	08-09	76.049	67.043	36.380
	09-10	98.331	66.238	51.266
	10-15	45.878	39.393	19.016
Total Lending	01	49.981	49.882	46.953
	02	51.271	50.737	43.728
	03	33.477	31.906	20.428
	04	47.988	45.043	29.523
	05	61.127	56.862	37.922
	06	64.883	59.140	36.472
	07	69.007	61.741	35.544
	08	72.000	63.347	33.890
	09	93.305	81.687	48.084
	10	43.966	37.735	18.185
Borrowing from Commercial Banks	01	31.563	31.563	31.563
	02	10.230	9.662	5.450
	03	18.337	17.113	11.482
	04	24.600	22.591	15.167
	05	26.207	23.570	14.491
	06	29.150	25.796	15.156
	07	31.147	27.085	14.960
	08	31.850	27.232	13.780
	09	50.907	44.134	28.358
Standard Deviation		3.558	3.143	1.710
Solution		A.5	A.6	A.7

Table 30. ADBP Model, Sources and Uses of Funds with Higher Cost of Funds and without Government Subsidy (total of 10 years)

Variable	without restriction on small loans	with higher cost of funds	with higher cost of funds and without government subsidy
Internal Resources		**Sources of Funds**	
Loan Recovery and Interest Earnings	646.456 (69.47)	595.644 (69.71)	400.656 (72.56)
Government Subsidy	29.943 (3.22)	29.943 (3.50)	0.000 (0.00)
Other Resources	2.369 (0.25)	2.369 (0.28)	2.369 (0.43)
Sub Total	678.768 (72.94)	627.956 (73.49)	403.025 (72.99)
External Resources			
Borrowings from CBs	243.823 (26.29)	218.588 (25.58)	141.245 (25.58)
Borrowings from IFAs	7.874 (0.84)	7.874 (0.92)	7.874 (1.43)
Sub Total	251.697 (27.06)	226.462 (26.51)	149.119 (27.01)
TOTAL	930.465 (100.00)	854.418 (100.00)	552.144 (100.00)
		Uses of Funds	
Operating Costs			
Salaries	58.280 (6.27)	55.750 (6.53)	52.367 (9.48)
Operating Expenses	1.203 (0.13)	1.136 (0.13)	0.876 (0.16)
Sub Total	59.483 (6.40)	56.886 (6.66)	53.243 (9.64)
Financial Costs			
Amortization of Borrowings	255.916 (27.51)	232.355 (27.20)	140.569 (26.54)
Interest Payments	33.921 (3.64)	36.865 (4.31)	24.332 (4.41)
Sub Total	289.837 (31.16)	269.220 (31.52)	170.901 (31.05)
Loan Issuance	580.906 (62.4)	528.080 (61.82)	328.05 (59.41)
TOTAL	930.226 (100.00)	854.186 (100.00)	552.194 (100.00)
Solution	A.5	A.6	A.7

Note: Numbers in parenthesis are column percentages of sources and uses of funds.

and total lending diminished by 61 percent. The bank became more dependent on loan recovery even though the volume of loans collected declined by 48.6 percent, while borrowings from commercial banks also declined by 54.7 percent. In terms of the uses of funds there was a small decline in operating expenses and a further decline in the relative importance of loan issuance which declined from 61.82 percent to 59.41 percent of the portfolio.

The loan portfolio was adjusted accordingly in response to the more expensive funds and the withdrawal of government subsidies. Table 31 shows that the bank would find it less profitable to issue large loans in spite of their cost effectiveness. The bank showed a preference for medium size loans which increaed even when the total number of loans declined. Insurance continued to be of value to the bank as the total number of insured loans remained practically constant.

This analysis suggests that in the years ahead, a raise in the cost of funds to the bank along with a significant reduction in government subsidies would severely restrict agricultural development banking. To minimize this negative impact, ADBs would have to be more efficient in the management of their loan portfolios. Another consideration would be to enlarge the banks' portfolios and diversifying their functions.

Table 31. ADBP Model, Total Number of Loans by Size and Insurance Class in Various Situations.

Variable	Risk neutral with insurance	risk neutral without insurance	withouth restriction on small loans	with higher cost of funds	with higher cost of funds and without government subsidy
			Total number of loans		
Small	25156	25156	-	-	-
Medium	18663	4685	19790	19816	20154
Large	19030	19126	21281	19022	10447
Total	62849	48967	41071	38838	30601
			Insured and not insured loans		
With	33567	0	20067	20067	19965
Without	29282	48967	21004	18771	10636
Solution	A.1	A.3	A.5	A.6	A.7

A Way Out: Diversified Banking

It is well recognized that diversification can provide one of the best strategies for bank financial management. The diversification should be allowed in the sources and uses of funds in order to generate more resources. For an agricultural development bank, lending for development purposes can be financed by generating surpluses in the bond portfolio and attracting more funds through demand and time deposits. Within the bank's leverage requirement, these changes will contribute to enlarge the bank's capital and its overall size.

To simulate a situation of diversified banking, the model was modified by allowing the issuance of bonds of one and two years maturity with nominal value of US$1000 and by allowing the handling of savings and checking accounts. Savings accounts could be of three average sizes: US$1,000, US$10,000, and US$100,000. Checking accounts could be of US$10,000 and US$100,000. It was assumed that the bank could still borrow from commercial banks at a rate of 8 percent. All other constraints were held as in solution A.7.

The leverage requirement is an important constraint in determining the structure of the bank's portfolio. The data in Table 32 reveals that the new opportunities for the bank have a significant impact on reducing the shadow price on the leverage requirement. In fact, it could be interpreted that

Table 32. ADBP Model, Shadow Price on Leverage Requirements.

Year	Specialized Banking	Diversified Banking Basic Solution
1	0.841	0.155
2	3.041[a]	1.779[a]
3	0.635	0.070
4	0.433	0.086
5	0.382	0.153
6	0.324	0.206
7	0.266	0.233
8	0.209	0.032
9	0.145	0.067
10	0.094	0.026
Solution	A.7	B.1

[a] Leverage requirements on year 2 are significantly larger than in other years because of financial commitments.

the new sources and uses of funds increase considerably the bank's financial performance.

The bank's external resources were primarily borrowings from commercial banks and only in two years the portfolio included checking account deposits. It is important to point out that there is no specific intertemporal linkage in terms of the number of savings and checking accounts that should be maintained. Therefore, the current formulation of the model assumes that at the end of any period the bank could close all its savings and checking accounts. Table 33 indicates that the model included a significant volume of deposits in years one and three. This occured because the prior loan repayment schedule of the bank resulted in a shortage of funds and hence the need for deposits. It is assumed that the bank could attract as much in deposits as it needed.

With respect to internal resources the bank was able to expand its loan recovery and obtain significant revenues from its bond portfolio. There was no specific restriction on the proportion of loans and bonds in the asset portfolio. On the aggregate this proportion was 1:4; however, it is important to notice a significant change in the composition of the asset portfolio over the planning horizon. This flexibility in the model should in fact reflect the institutional ability to adjust the bank portfolio over the business cycle, depending

Table 33. ADBP Model, Borrowing and Deposits with Specialized and Diversified Banking (million US$).

Variable	Year	Specialized Banking	Diversified Banking Basic Solution
Borrowing from Commercial Banks	1	31.563	31,563
	2	5.450	121,550
	3	11.482	246,385
	4	15.167	254.999
	5	14.491	265.548
	6	15.156	276,740
	7	14.960	284.526
	8	13,780	296.727
	9	28.358	328,413
	10	-	-
	Total	150.407	2106.451
Demand and Time Deposits	1	-	9147.800[a]
	2	-	-
	3	-	239641.2[a]
	4	-	-
	5	-	-
	6	-	-
	7	-	-
	8	-	-
	9	-	-
	10	-	-
	Total	-	248789.000
Solution		A.7	B.1

[a] Deposits in Checking accounts only. It should be recalled that because leverage and reserve requirements, only a portion of these funds can be used in investment and lending activities.

on the relative profitability of the various financial instruments. Earlier work of the author (Pomareda, 1982.a) using an econometric model, showed different elasticities of bank demand for loans, municipal securities and treasury securities in the U.S. when interest rates were rising than when they were falling.

As shown in Table 34, allowing multiple functions is an important way of increasing the capacity of the bank to allocate funds to agricultural loans. In this case no specific demand was imposed on the number of small loans, hence the bank's lending activity was primarily for large loans and some medium loans. Presumably, in this case the requirements of serving small farmers could be imposed without a significant detriment in the bank's aggregate performance.

The above discussion has illustrated that allowing the ADBs to fulfill multiple functions, is potentially an important strategy by which the banks can expand their portfolios and generate surpluses to finance agricultural development. However, as the cost of funds to the banks become higher, they will findit increasingly difficult to finance agricultural loans at low rates. This situation is illustrated with the data in Table 35, where the cost of funds from commercial banks was increased from 8 percent/year to 10 percent/year.

Table 34. ADBP Model, Net Returns, Loans and Bonds with Specialized and Diversified Banking (millions US$).

Variable	Year	Specialized Banking	Diversified Banking
Objective		145.737	1872.690
st. dev.		1.711	8.264
Net Returns at end of Period	1	36.438	41.431
	2	9.823	136.009
	3	13.525	378.547
	4	18.119	282.739
	5	18.283	295.042
	6	18.803	308.232
	7	18.514	317.673
	8	17.169	323.144
	9	33.167	363.442
	10	1.818	19.181
	Total	185.659	2465.44
Loan Issuance	1	46.953	50.564
	2	43.728	128.592
	3	20.428	3.625
	4	29.523	115.016
	5	37.922	118.439
	6	36.472	136.321
	7	35.544	140.128
	8	33.890	20.980
	9	48.084	139.210
	10	18.185	173.876
	Total	350.729	1026.751
Security Purchases	1	-	86.071
	2	-	115.917
	3	-	363.677
	4	-	435.851
	5	-	592.973
	6	-	579.789
	7	-	538.838
	8	-	624.311
	9	-	496.610
	10	-	176.585
	Total	-	4010.622
Solution		A.7	B.1

Table 35. ADBP Model, Interest Rate Sensitivity of Borrowings, Lending and Purchase of Securities (million US$).

Variable	Rate on borrowings = 8% Basic rate on loans	Rate on borrowings = 10% Basic rate on loans	Rate on borrowings = 10% Rate on loans increased by 2%
Total Utility	1872.69	1931.827	1943.118
Borrowings	2106.453	2166.818	2184.582
Deposits	248789.000	258987.800	253055.8
Loan Issuance[a]	1036.752	782.124	862.044
Purchase of Securities	3580.759	4010.622	3984.284
Amortization of Borrowings	339.012	434.081	437.632

[a]See end note 2 in this chapter.

Two important effects of adjustment on the bank's portfolio take place as interest rates on borrowed funds increase. On the liability side the bank would increase its demand for deposits relative to borrowings. On the asset side the bank would increase the investment in bonds and decrease the issuance of loans. Table 35 shows that there would be a slight increase in borrowings even when interest rates are higher. It should be recalled, however, that what the bank is looking for is the net availability of borrowed funds. Therefore, the bank must borrow larger volumes because amortization of interest payments is now a larger proportion of the uses of funds.

The alternative of increasing the interest rates on loans was also evaluated by assuming an average increase of 2 percent on returns of all loans. The results in the last column of Table 35 suggests that this policy will result in an increased preference by the bank to issue loans and a decline in the relative preference for securities. The average elasticity of bank demand for loans is 5.0.[2] But as borrowings also increase (while deposits practically do not change), the subsitution of securities for loans is not as significant. In fact, the elasticity of substitution of loans for securities was equal to 0.324, but it should be recalled that the volume of securities is four times that of loans.

Concluding Comments

The analyses performed here are a sample from an infinite number of possible scenarios. In this sense the uses of the model go far beyond what has been shown here. The real output of this work is the model itself and the analysis of particular issues of interest. But as other questions are presented by the bank's authorities those questions can be resolved with the aid of the model.

It should be recognized on the other hand that the current version of the model could be enriched considerably by further disaggregation, in the loan classes, in the sources of funds, in the investment portfolio, in the number of financial, physical and institutional constraints, and in the average size of periods in the planning horizon. If necessary the model could also be disaggregated by regions or agencies, but this would considerably enlarge the size of the model.

The most important elements of the model are the loan vectors. If the model was to be improved, it should be in the specification of loan classes with alternative levels of loan supervision as this is an important determinant of loan recovery. In fact, the benefits of insurance are so significant in the model because insurance improves loan recovery and reduces administration costs. Yet, at least part of these benefits could be achieved through improved loan management.

It should be kept in mind that insurance is justifiable only if the long term benefits of it are greater than the cost to the bank, the insurer and the farmer.

End Notes

[1]It is assumed that the bank issues only one loan per farmer.

[2]This elasticity of bank demand for loans actually reflects the banks' marginal cost function of loan issuance (see Pomareda, 1982.a). It was calculated as the percentage change in loan issuance divided by the percentage change in interest rates

$$\frac{(862.44-782.128)/782.128}{.02} = 5.11$$

which means that an increase of one percent in interest rates on loans (e.g., from 9 to 10 percent per year) will increase the bank's demand for loans by 5.11 percent.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The objective of this study was to analyze the impact of various policies on the growth of ADBs. The policies with which the study was concerned referred to the effect of risk aversion in the management of funds, the requirement of credit insurance on agricultural and livestock production loans, the measurement of the bank's opportunity cost of serving small farmers, the portfolio adjustments resulting from higher cost of funds and the withdrawal of government subsidies and finally the effects of transforming a specialized lending bank into one with multiple functions.

The institutional design of ADBs and the interest rate policies for agriculture were discussed. Many ADBs are specialized lending institutions and this limits their financial intermediation capacity. There are diverse views about the justification of interest rate policies, but it is well recognized that they introduce distortions in the rural capital markets. Because of the clientele ADBs serve, they face high operating costs. Therefore, low interest earnings and high costs determine low net returns to the bank and poor quality of service.

A generalized characteristic of ADBs is their poor loan collection performance. This is due in part to agricultural

risks. Agricultural insurance and credit insurance are proposed as a means for stabilizing farm income, when its variability originates on yield instability. The effectiveness of insurance in stabilizing farm income depends on the origin of risks. Furthermore, even when income could be fully guaranteed there could still be low loan repayment because of moral risk.

In order to evaluate the policies considered, a multiperiod linear programming model was constructed. The method used was based on portfolio theory and on earlier bank portfolio models. The most interesting features of the model are the integration of financial, institutional, and physical constraints; the intertemporal linkages in assets and liabilities portfolio; a very disaggregated loan portfolio with 26 classes of loans; and a linearized measure of risk that captures variance-covariance effects on the loan portfolio in each period of the planning horizon. The model was applied to the case of the ADP of Panama (ADBP) for a 10-year planning horizon. The loan classes were defined on the basis of a survey of 900 loans issued between 1974 and 1980. The average size, expected and actual recovery, and expected and actual maturity were estimated for each loan class.

The model was structured by 298 equations and 513 variables. The model was tested for the appropriateness of the length of the planning horizon and the sensitivity to the discount rate.

A ten year horizon was sufficient to analyze policies that do not modify the maturity structure of assets and liabilities. The model solutions were sensitive to the discount rate, which means that this model can be applied to financial institutions with varying degrees of ownership and hence different strategies for distribution of earnings at the end of each planning period.

The main conclusions of the study were the following:

i) Increased risk aversion provided a more stable growth of the bank, because, although total utility decreased, it can be expected with more certainty. Increased risk aversion would become more important as financial support from the government and soft international loans diminish.

ii) Agricultural credit insurance provides direct benefits for an ADB through higher average recovery, decreased variations of recovery over time, reduced administration and collection costs. These benefits increase as production risk becomes a more important factor in loan recovery . Credit insurance allows for reduction of costs and increase of earnings, both of which allow a faster growth of credit. Credit insurance provides the largest benefits when issuing large loans in the case of the ADBP, but this can not be generalized to other banks.

iii) Serving small farmers increased the bank's operating costs, but the net effect on slowing bank growth was mitigated

by the fact that small loans are less risky and that they have shorter actual duration than medium and large loans. Their inclusion on bank portfolios should be considered on the basis of cost, return, and risk characteristics. All these factors could vary from crop to crop for the same size of loan.

iv) Increased cost of borrowings from commercial domestic and international banks imposes a severe constraint for the growth of specialized ADBs,if they do not increase interest rates on loans issued. These increased costs could be afforded with government subsidies, but as the latter diminish, those banks that do not adjust their spreads will tend to disappear.

v) Moving a bank from specialized lending to multiple functions will require significant changes in institutional design and management, but it may be the only way for ADBs to exist when international soft loans and subsidies are no longer available. However, even in this case ADBs will need to increase interest rates on issued loans. But they could also in this case maintain separate portfolios for development oriented (low interest rate) loans and commercial loans.

These conclusions pertain to the main findings of this study. They can not be generalized to all ADBs yet they

delineate issues for further research in ADBs in the developing countries and even in some developed countries where institutional design and interest rate policies fall within the general framework presented here.

CHAPTER VII

RECOMMENDATIONS

This study has derived several conclusions, not only from an empirical analysis of Panama's ADB, but also from the general review of bibliography and analysis of financial policies, design, and performance of ADBs. On this basis the study offers a set of recommendations of direct relevance for the ADBP, but also of interest for ADBs in general.

Because the specialized nature of ADBs inhibits them from playing a more meaningful role in the supply of agricultural credit, ADBs are well advised to diversify their functions. This would allow ADBs to afford the withdrawal of government subsidies and the expected relative smaller contribution of international development financial agencies. However, diversification would imply charging higher rates on loans in order to maintain a positive spread as the attraction of savings deposits will be possible only at competitive rates. The banks should, however, explore the possibility of maintaining loan portfolios with different rates to the extent that the banks (or the government) wish to continue favoring particular groups.

As an overall strategy, increasing interest rates to agriculture should be considered. This policy could attract more funds for investment in agriculture and it is not likely to

to create a lasting decrease in the demand for agricultural credit by farmers. The shift towards rates more consistent with inflation and structure of the countries' capital markets should allow an increase in the immediate and long term availability of credit and it would allow the banks to offer a service of better quality.

ADBs that so far have been primarily government owned should be given more financial freedom. The above will allow them to take a more professional attitude towards management and hence, enforce loan selection supervision and prosecution that is not distorted by political maneuvers. Coupled with the above must be the awareness of dependence on self performance rather than bargaining ability to obtain government funds.

It has been shown that credit insurance can provide important benefits for an ADB. However, to the extent that loan defaults are due only partially to production risks, caution must be exercised in the creation of credit insurance programs, as these are not a substitute for better bank management. Furthermore, credit insurance should be favored only when the costs of insurance do not exceed the direct immediate and spillover long term effects of increased loan recovery. Insurers should also be given financial freedom to avoid indemnities made for political reasons which could be to costly to the insurer.

Credit to small farmers imposes an important cost to a bank in terms of the number of clients to be served. But the decisions about inclusion of small loans in bank portfolios should be based not only in terms of operating costs, but on the risk of recovery and maturity of the loans. It is necessary to consider these factors because if in fact small loans are not cost efficient, they may be less risky and they could have shorter maturities. Hence, on the aggregate some small loans may be prefered to large loans.

As far as management, ADBs have much to gain from the use of analytical tools, operations research methods and statistical analysis of their own experience. In this regard, this study has shown that the analysis of data and the use of a mathematical model with that data is an important element to highlight the existence of problems. Furthermore, the models offer the chance for systematic thinking and certainly offer a guide for policy analysis. The use of the analytical tools among development banks makes sense to the extent that the bank authorities want to rely on professional advice to evaluate the financial cost of political decisions.

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APPENDICES

A. Risk and Return Characteristics of Loans, 1974-198.

B. Coding for the Linear Programming Model, BANK

Appendix A. Risk and Return Characteristics of Loans, 1974-1980

	Amount Disbursed	Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Real Rate of Interest	Ex Post Rate of Interest	R_t	d_t
					RI01					
1974	334	8.14	397	12.43	23.57	63.00	.800	10.56	486	8.5
1975	330	8.00	360	7.00	19.00	30.00	.478	6.31	526	40.5
1976	445	9.00	461	7.33	17.00	16.00	.211	2.78	461	-26.5
1977	457	8.60	478	9.80	9.20	21.00	.499	6.59	478	- 9.5
1978	160	9.00	168	6.67	9.66	8.00	.517	6.82	479	- 8.5
1979	515	10.00	545	8.50	11.00	30.00	.529	6.98	480	- 7.5
1980	900	12.00	919	3.00	3.00	19.00	.704	9.29	491	3.5
$\bar{x}$	449	9.25	475	7.82	13.20	27.00	.534	7.05	487.5	-
					RI02					
1974	2887	8.67	3012	7.56	15.00	125.00	.289	3.39	5183	- 92
1975	5252	8.94	5492	7.50	11.31	241.00	.406	4.77	5252	- 23
1976	3419	8.50	3793	7.50	21.00	374.00	.521	6.11	5319	44
1977	3870	9.64	4071	7.18	9.82	201.00	.529	6.21	5324	49
1978	9999	10.00	10320	12.00	10.00	321.00	.321	3.77	5202	- 73
1979	3413	10.00	3548	7.00	7.57	134.00	.518	6.08	5318	43
1980	6311	11.50	6561	4.50	7.50	250.00	.528	6.20	5324	49
$\bar{x}$	5013	9.61	5257	7.60	11.74	735.00	.444	5.22	5275	-
					RI03					
1974	42944	8.00	44182	3.00	11.00	1239.00	.262	2.88	22261	-338
1975	15746	9.33	16563	7.00	7.67	818.00	.677	5.19	22761	164
1976	15458	9.00	15857	11.00	8.00	399.00	.323	2.59	22196	-401
1977	31903	9.50	33126	13.00	11.75	1223.00	.326	3.83	22467	-130
1978	14179	10.00	14841	10.00	26.00	662.00	.179	4.65	22644	47
1979	14000	10.00	14950	6.00	7.00	950.00	.969	6.78	23105	508
1980	17235	12.00	18120	9.00	13.00	885.00	.395	5.13	22748	151
$\bar{x}$	21638	9.69	22520	8.43	12.06	882.00	.447	4.43	22597	-
					RI11					
1974	-	-	-	-					0	0
1975	-	-	-						0	0
1976	-	-	-						0	0
1977	-	-	-						0	
1978	591	9.00	616	5.50	5.00	25.50	.862	3.45	609	9
1979	796	10.00	608	6.00	4.00	12.00	.503	2.01	601	-8
1980	581	11.00	595	6.00	3.00	14.00	.803	3.21	606	2
$\bar{x}$	589	10.00	606	5.83	4.00	17.00	.723	2.89	606	-
					RI12					
1974	-									
1975	-									
1976	-									
1977	-									
1978	4246	9.50	4334	7.50	7.50	88.00	.276	1.98	4815	-77
1979	3656	10.58	4020	3.21	5.16	168.00	.521	3.24	4899	17
1980	6064	11.00	6305	7.33	5.92	240.00	.667	4.79	4948	66
$\bar{x}$	4722	10.36	4886	7.60	7.19	164.00	.488	3.00	4887	-

Appendix A. cont'

	Amount Disbursed	Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Real Rate of Interest	All Maturity Rate of Interest	R_t	d_t
					RI13					
[illegible]										
[illegible]	-									
1976	-									
1977	-									
[illegible]	16882	11.00	17685	8.50	9.00	803.00	.528	4.39	23253	- [illegible]
1979	20031	11.00	20941	7.33	9.33	910.00	.487	4.06	23179	-144
[illegible]	29913	12.80	31270	8.20	6.67	1357.00	.680	5.66	23536	214
$\bar{x}$	22275	11.60	23299	8.01	8.33	1023.00	.565	4.70	23323	-
	-	-			CO01					
[illegible]	417	8.00	464	6.64	19.21	47.00	.387	7.52	473	- 8
[illegible]	425	8.41	456	10.65	16.18	31.00	.451	5.78	465	-16
[illegible]	401	8.44	420	8.37	8.19	19.00	.578	7.40	472	- 4
1977	531	8.89	577	8.20	18.27	46.00	.474	6.07	458	- 6
[illegible]	460	8.87	493	8.81	10.50	33.00	.683	8.75	478	8
[illegible]	287	9.21	310	8.14	8.71	23.00	.920	11.78	492	16
[illegible]	559	10.36	594	9.18	8.64	35.00	.725	9.29	481	5
$\bar{x}$	440	8.88	473	8.57	12.81	33.00	.631	8.08	476	-
					CO02					
[illegible]	1254	8.00	1292	5.00	6.00	38.00	.505	6.82	1459	-16
[illegible]	2448	8.50	2820	14.00	37.00	377.00	.417	5.63	1443	-28
[illegible]	1000	8.50	1047	10.00	16.00	47.00	.294	3.97	1420	-48
1977	1600	9.00	1750	10.00	14.00	150.00	.669	9.03	1489	28
[illegible]	1000	9.00	1025	5.00	3.00	25.00	.833	11.24	1519	58
[illegible]	1000	9.25	1061	8.00	13.50	61.00	.452	6.10	1449	-26
[illegible]	1267	9.67	1314	6.67	5.00	48.00	.758	10.23	1506	37
$\bar{x}$	1366	8.84	1473	8.38	13.5	106.00	.561	7.57	1469	-
					CO11					
[illegible]										0
[illegible]										0
[illegible]										0
[illegible]										0
1978	729	8.5	755	6.50	6.50	26.00	.540	4.71	783	-14
1979	678	9.00	743	6.00	9.25	64.00	1.020	8.75	813	15
1980	836	11.00	899	7.00	10.00	62.00	.742	6.37	796	- 1
$\bar{x}$	748	9.5	799	6.50	8.58	51.00	.770	6.61	737	-

Appendix A con't

	Amount Disbursed	Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Real Rate of Interest	SEE Maturity Rate of Interest	R_t	d_t
					CO12					
1974										
1975										
1976										
1977	1619	10.00	1685	4.00	4.00	66.00	1.019	8.45	2479	56
1978	4700	9.50	4875	8.50	14.50	175.00	.255	2.11	2334	-89
1979	1140	10.00	1228	8.00	8.00	88.00	.965	7.99	2465	42
1980	1684	10.33	1760	6.67	6.67	76.00	.677	5.61	2414	- 9
$\bar{x}$	2286	9.96	2387	6.79	8.29	101.00	.729	6.04	2423	-
					IT01					
1974	257	8.00	276	4.20	17.70	19.00	.418	5.92	459	- 7
1975	298	8.00	323	3.33	13.33	25.00	.629	9.91	471	5
1976	345	8.00	374	4.83	22.67	30.00	.383	5.43	456	-10
1977	800	8.00	937	5.00	29.00	137.00	.590	8.36	469	3
1978	185	9.00	191	4.00	6.00	6.00	540	7.65	466	0
1979	422	9.50	435	4.38	4.50	13.00	.684	9.69	475	9
1980	622	10.33	641	4.67	6.00	20.00	.536	7.59	466	0
$\bar{x}$	433	8.69	457	4.55	14.17	36.00	.470	7.65	466	-
					IT02					
1974	1000	8.00	1212	10.00	53.00	212.00	.4	5.12	1702	-40
1975	2000	8.00	2065	4.00	6.00	65.00	.542	6.94	1731	10
1976	1800	8.00	1870	6.00	7.00	70.00	.555	7.10	1734	- 7
1977	2000	8.00	2060	6.00	6.00	60.00	.5	6.40	1723	-18
1978	2000	10.00	2081	6.00	6.00	81.00	.675	8.64	1759	18
1979	1000	10.00	1031	6.00	6.00	31.00	.517	6.62	1726	-15
1980	1531	11.00	1611	3.40	5.60	81.00	.945	12.10	1815	73
$\bar{x}$	1619	9.00	1704	5.91	12.80	86.00	.590	7.56	1741	-
					IT11					
1974										
1975										
1976										
1977	-									
1978	150	9.00	157	6.00	6.00	7.00	.777	9.59	498	4
1979	433	9.00	448	4.67	4.00	15.00	.866	9.90	493	2
1980	600	9.50	612	4.50	3.50	12.00	.571	2.60	484	-3
$\bar{x}$	394	9.17	403	5.06	4.50	11.30	.738	3.33	407	-
					IT12					
1974										
1975										
1976										
1977	-									
1978	1500	12.00	1571	5.00	5.00	71.00	.947	4.57	1670	9
1979	1000	10.00	1044	5.00	5.00	44.00	.88	4.25	1665	4
1980	2290	10.50	2358	7.00	4.50	68.00	.659	3.18	1648	-13
$\bar{x}$	1597	10.83	1658	5.67	4.83	61.00	.829	4.00	1661	-

Appendix A. con't

	Amount Disbursed	Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Real Rate of Interest	All Maturity Rate of Interest	R_t	d_t
					IT12					
1974	502	8.09	535	5.27	12.73	33.00	.516	6.04	536	3
1975	747	8.26	772	6.00	6.50	25.00	.515	6.02	535	2
1976	619	8.87	655	11.00	26.67	36.00	.218	2.55	518	-15
1977	290	8.28	313	5.14	12.57	23.00	.631	7.38	542	9
1978	437	8.88	465	6.11	7.89	17.00	.493	5.77	534	1
1979	481	9.00	495	4.43	9.71	14.00	.299	3.49	523	-10
1980	463	10.00	481	5.62	5.87	18.00	.662	7.74	544	10
$\bar{x}$	505	8.75	530	6.22	11.70	24.00	.476	5.57	533	-
					VG02					
1974	2780	8.33	2881	6.33	7.67	121.00	.572	5.70	2481	- 3
1975	2891	8.91	2569	7.54	12.73	178.00	.585	5.83	2484	0
1976	1644	9.00	1731	6.00	10.56	87.00	.501	4.99	2464	-20
1977	2275	9.50	2388	6.00	9.25	113.00	.537	5.36	2472	-12
1978	1943	9.00	2033	6.00	17.00	190.00	.606	6.08	2520	36
1979	3304	10.20	3441	5.00	6.40	47.00	.216	2.15	2397	-87
1980	2926	10.67	2460	5.22	6.11	135.00	.950	9.46	2569	85
$\bar{x}$	2376	9.37	2500	6.01	9.96	159.00	.567	5.65	2484	-
					CF01					
1974	480	8.00	522	9.47	14.74	33.00	.458	5.76	518	- 5
1975	481	8.00	514	10.12	11.81	23.00	.405	5.09	515	- 6
1976	566	8.00	612	13.50	19.75	47.00	.420	5.28	516	- 7
1977	412	8.14	436	11.57	10.86	24.00	.536	6.74	523	0
1978	553	8.71	599	11.14	12.00	46.00	.693	8.72	533	10
1979	300	9.09	317	10.91	9.73	17.00	.582	7.32	526	3
1980	630	10.20	669	9.00	9.20	39.00	.673	8.47	531	8
$\bar{x}$	490	8.59	524	10.81	12.58	33.00	.538	6.77	523	-
					CF02					
1974	2811	8.00	3001	10.21	17.50	189.00	.384	4.80	2564	-46
1975	2846	8.00	3062	10.00	18.33	216.00	.414	5.18	2574	-36
1976	1806	8.00	1907	11.33	15.00	101.00	.373	4.67	2561	-49
1977	3224	8.50	3318	7.00	5.50	94.00	.530	6.63	2609	1
1978	2097	9.67	2254	14.00	14.00	157.00	.535	6.69	2611	3
1979	1906	10.37	2036	12.12	10.00	130.00	.682	8.53	2656	48
1980	2439	11.37	2583	9.00	7.25	144.00	.814	10.18	2696	86
$\bar{x}$	2447	9.13	2557	10.52	12.51	110.00	.533	6.67	2610	-
					LV01					
1974	708	8.00	817	51.00	36.00	117.00	.464	13.14	691	-20
1975	450	8.00	531	40.00	26.00	81.00	.692	19.60	732	20
1976	500	8.00	594	49.00	49.00	94.00	.384	10.88	677	-34
1977	700	9.00	761	8.00	16.00	61.00	.545	15.44	705	- 6
1978	510	12.00	581	16.00	22.00	62.00	.543	15.38	705	- 6
1979	800	10.00	942	24.00	21.00	142.00	.845	23.94	755	45
1980	-	-	-	-	-	-	-	-	-	-
$\bar{x}$	611	9.17	704	31.33	28.33	93.00	.570	16.40	711	-

Appendix A. con't

	Amount Disbursed	Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Real Rate of Interest	Real Maturity Rate of Interest	R_t	d_t
					LV02					
1974	3028	8.00	3878	30.05	57.48	848.00	.467	16.19	4637	-96
1975	1831	8.75	2364	69.50	51.25	533.00	.568	18.00	4741	8
1976	3698	8.71	4129	49.29	42.71	439.00	.278	9.24	4336	-337
1977	2090	9.00	2258	11.00	11.00	168.00	.749	24.89	4981	248
1978	5468	10.67	6215	21.33	22.00	727.00	.602	20.01	4786	53
1979	7800	12.00	8600	13.00	15.00	800.00	.684	22.74	4886	152
1980	-	-	-	-	-	-	-	-	-	-
$\bar{R}_t$	3988	9.60	4574	37.36	33.24	586.00	.561	18.66	4733	-
					LV12					
1974										
1975										
1976										
1977										
1978	4415	12.00	4887	23.00	13.00	472.00	.822	12.39	5858	28
1979	5653	12.17	6379	24.33	17.17	726.00	.748	11.28	5602	-28
1980										
$\bar{R}$	5034	12.08	5633	23.66	15.08	599.00	.785	11.83	5630	-
					ϕT01					
1974	521	6.00	552	6.86	7.29	21.00	.542	8.26	555	- 1
1975	280	8.00	302	56.00	56.00	22.00	.140	2.13	524	-38
1976	570	8.00	590	5.33	9.33	21.00	.389	5.93	543	-18
1977	534	8.00	568	6.60	9.60	34.00	.663	10.10	565	6
1978	540	9.22	581	13.22	9.89	41.00	.768	11.70	573	17
1979	567	10.00	581	7.80	6.80	25.00	.648	9.87	564	8
1980	560	10.80	589	13.20	7.80	30.00	.687	10.47	567	11
$\bar{R}$	513	8.97	540	15.57	15.24	28.00	.548	8.35	556	-
					ϕT02					
1974	1806	8.00	2044	23.60	19.80	158.00	.423	5.66	2595	-42
1975	1999	8.80	2170	6.80	21.60	171.00	.396	5.30	2586	-51
1976	2768	9.00	2850	5.00	6.00	82.00	.494	6.61	2618	-19
1977	2679	9.00	2954	11.00	13.00	275.00	.789	10.56	2715	78
1978	2919	10.00	3263	18.12	16.50	343.00	.712	9.53	2690	53
1979	1677	10.00	1743	7.00	8.33	66.00	.472	6.32	2611	-26
1980	3265	10.00	3422	8.00	8.50	157.00	.566	7.58	2642	5
$\bar{x}$	2458	9.26	2635	11.36	13.39	179.00	.550	7.36	2637	-
					ϕT11					
1974										
1975										
1976										
1977										
1978	865	10.00	902	5.00	9.00	37.00	.475	3.17	715	- 3
1979	648	10.00	671	5.00	6.00	22.00	.566	3.77	719	1
1980	565	9.00	582	5.20	5.00	17.00	.602	4.01	721	2
$\bar{y}$	693	9.67	718	5.00	6.67	25.00	.548	3.65	718	

Appendix A. con't

	Amount Disbursed	Interest Rate	Amount Collected	Expected Duration	Actual Duration	Net Interest	Monthly Real Rate of Interest	All Maturity Rate of Interest	R_t	C_t
					ϕT12					
1974										
1975										
1976										
1977										
1978	4987	10.00	5197	5.00	8.33	210.00	.505	4.47	3868	11
1979	3210	10.43	3435	5.29	13.00	225.00	.539	4.47	3879	-
1980	2913	9.78	3001	5.44	5.22	88.00	.579	5.12	3892	11
x̄	3703	10.07	3878	5.24	8.85	174.00	.541	4.79	3879	-
					RA03					
1974										
1975	28538	8.00	29421	11.50	15.50	882.00	.199	2.74	37249	-671
1976	56438	8.00	57500	30.00	8.00	1062.00	.235	3.24	37431	-490
1977										
1978	41561	8.20	43435	8.00	22.80	1874.00	.198	2.73	37246	-676
1979	44397	8.00	48322	13.00	16.67	3925.00	.530	7.31	39906	984
1980	10344	10.00	10656	8.00	6.00	312.00	.503	6.94	38772	851
x̄	36256	8.44	37867	14.1	13.79	1611.00	.338	4.59	37921	

Appendix B. Coding for the Linear Programming Model, BANK

The coding used to define rows and columns in the model uses eight characters to define each vector. In the rows section the name is preceded by an indication of the inequality as follows:

N	indicates no restriction
G	indicates greater or equal ($\geq$)
L	indicates less or equal ($\leq$)
E	indicates equal (=)

The eight characters are interpreted as in the following example for the fourth row:

1	A	amortization
2-3	BF	borrowed funds
4	.	blank spaces
5	.	
6	.	
7-8	01	year of the model

In similar form in the case of the first column for example:

1	T	Transfer activity
2-3	LR	Loan Recovery
4-5	00	period of origin
6	.	always blank
7-8	.	year of the model

Appendix B. con't
The coding is the following:

Block 1. Type of activity or row

L loan

B borrowing

A amortization

C cost

I investment

T transfer activity

R restriction

E balance equation

D deposit

Block 2.3 Name of activity and institution

Loans for:

RI rice

CO corn - sorghum

IT industrial tomatoes

VG vegetables

CF coffee

LV livestock

OT other

Investments on

BD bonds

Appendix B. con't

Institutions

ID Interamerican Development Bank

WB World Bank

AI AID

CB Commercial Banks

Financial variables

LR loan recovery

LE leverage constraint

IE interest earnings (on loans)

GS government subsidy

OR other resources

OE operating expenses

OL outstanding loans

CD capital disbursements

SA savings

CH checking

IP number of insured loans

IC value of insured crops

IL value of insured livestock

CP crops loan constraints

LV livestock loan constraints

IN interest payments on borrowed funds

NR net returns

PN resources office staff requirements

VH vehicle requirements

Appendix B. con't

LT loan officer time

CT collection officer time

Block 4. Use of insurance

0 = No

1 = Yes

Block 5. Type of loan, bonds, saving and checking

Loans

1 = small ($1000)

2 = medium ($1000 - 10000)

3 = large ($10000)

Bonds

1 maturing within 1 months

2 maturing in two years

Checking

1 of average balance equal to $10000

2 of average balance equal to $100000

Savings

1 of average balance equal to $1000

2 of average balance equal to $10000

3 of average balance equal to $100000

Blocks 4.5. Year of origin of funds

01, 02,...20

Appendix B. con't

Block 6. Blank (always)

Blocks 7,8. Year of destination or year of collection of funds

01, 02,...10

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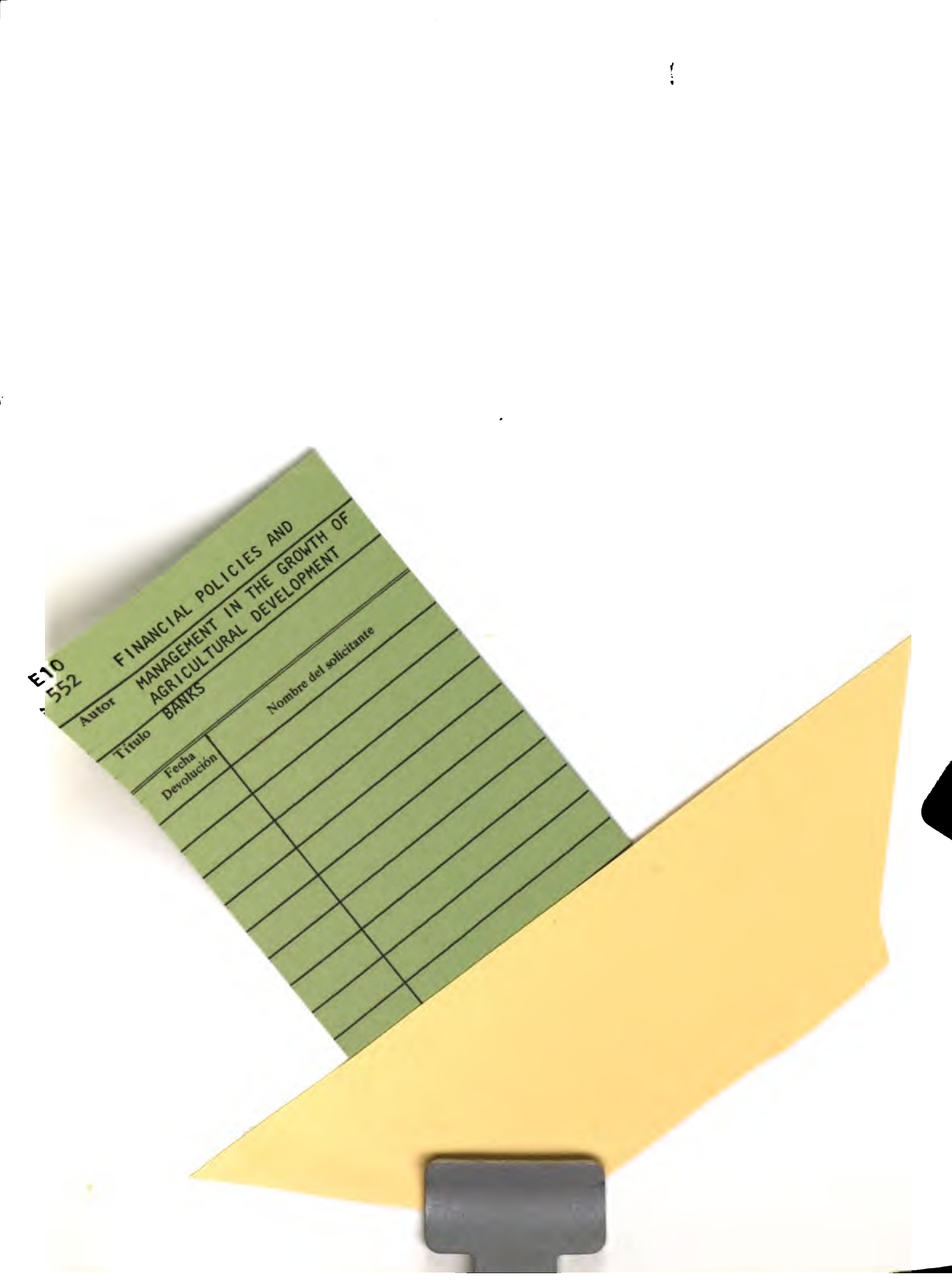
E10
552
Autor FINANCIAL POLICIES AND
MANAGEMENT IN THE GROWTH OF
AGRICULTURAL DEVELOPMENT
Título BANKS
Fecha Devolución
Nombre del solicitante