Access to Credit and Its Impact on Welfare in Malawi

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Foreword

For decades the poor in developing countries (and elsewhere) were essentially shut out of credit and savings services. Because the poor did not meet the traditional criteria for borrowing, financial institutions perceived them as bad credit risks. More recently, development practitioners have come to see that the poor can indeed make effective use of credit to raise their incomes and get access to more food and other necessities. In fact, in some quarters microcredit is now seen as the solution to poverty. Research conducted at IFPRI shows, however, that although credit can be an important tool in the fight against poverty, credit alone cannot be guaranteed to raise incomes, increase food security, and improve nutrition.

In this research report, Aliou Diagne and Manfred Zeller examine the case of Malawi, where several institutions offer credit to poor, smallholder farmers to allow them to buy fertilizer, seeds, and other inputs for growing maize and tobacco as a way of helping raise incomes. Surprisingly, they find that farmers who participated in these credit programs ended up with less net crop income than those who did not. Their results make clear that the conditions surrounding credit programs must be right—that is, they must reflect the actual opportunities and constraints faced by poor farmers—for credit to work effectively. For example, credit is not of much use in situations in which farmers have little access to roads, markets, health care, and communications infrastructure and are subject to drought that can wipe out their crops, as is the case in Malawi.

This research report reveals how complicated the task of effective rural development can be, but it also points to concrete steps, in addition to offering credit services, that governments and development organizations can take in their efforts to eradicate poverty and food insecurity. This research report should be of great significance to anyone interested in how rural finance can be made to work best for those in the most need—the poor and food insecure in developing countries.

Per Pinstrup-Andersen
Director General

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Our special gratitude goes to the members of the survey households, who during three survey rounds in 1995 gave of their precious time and who responded to numerous questions, some of which touched on very sensitive issues, such as their possession of assets, access to credit, and level of debt. We thank them for their trust and their contribution to what is essentially a public good that does not create any direct and immediate benefit for them. It is our hope that this report—in conjunction with prior reports, papers, policy summaries, and workshop proceedings disseminated in Malawi by the rural finance research program of Bunda College and IFPRI—will be effectively used by policymakers to improve the economic opportunities for and therefore the welfare of rural households in Malawi.

This research report and the underlying field research and data processing would not have been feasible without the essential and invaluable contribution of the research staff of the Bunda College of Agriculture, University of Malawi, and without the contribution of many others in Malawi, at IFPRI, and at other institutions. Foremost, we are grateful for the assistance of the staff of the Department of Rural Development (DRD) who contributed to the successful implementation of the field survey, data cleaning, and data analysis for the DRD/IFPRI Rural Finance Study. We thank Karid Chirwa, Tyme Fatch, Swalley Lamba, Samson Manda, and Franklin Simtowe, who provided invaluable research and administrative assistance. We especially thank Franklin Simtowe for his excellent research contribution to the in-depth descriptive analysis for this report, Dr. Alexander Phiri for helpful discussions during all phases of the research project, and Dr. Todd Benson for contributing critical comments and questions that sharpened the analysis presented here. We also enjoyed working with a number of students at Bunda College, notably Vinda Kisyombe, Mary Mandambwe, and Hardwick Tchale, who used the DRD/IFPRI Rural Finance data set for their M.Sc. research and who provided additional insights for the role of credit in rural development. Our utmost gratitude goes to Dr. Charles Mataya, whose support as head of the Department of Rural Development made this collaboration prosper over time.

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Summary

As in many countries in Sub-Saharan Africa, the majority of poor smallholders in Malawi are left out of the agricultural extension and credit systems. These households, characterized by landholdings of less than 1 hectare and very low crop yields, are unable to grow enough food to feed themselves even though they focus much effort on producing food crops, especially maize. It has been argued that most of these farmers are too poor and cash-strapped to be able to benefit from any kind of access to credit and that, even if they received adequate supplies of the right inputs, their land constraints are so severe that any increase in productivity would still fall short of guaranteeing their food security. For these households, credit to support nonfarm income-generating activities has been suggested as a policy alternative for alleviating their food insecurity.

To gain a better understanding of the possible role of credit in improving household food security and alleviating poverty in Malawi, in November 1994 the International Food Policy Research Institute and the Department of Rural Development, Bunda College of Agriculture, University of Malawi, initiated a research program on rural financial markets and household food security in Malawi. The main objective of the research program was to analyze the determinants of access to credit in Malawi and its impact on farm and nonfarm income and on household food security. The study also sought to quantify the relationship between the demand for formal loans and that for informal loans. From a policy perspective, such an analysis is important for at least two reasons. First, by quantifying the welfare impact of access to financial services, it can inform policymakers about the social benefits (if any) of policy strategies to promote the formation and expansion of microfinance institutions in rural areas. Second, the analysis can provide knowledge about the relative importance of the various socioeconomic factors within or beyond the control of policy that determine whether or not some households will benefit from access to formal credit. This latter information can guide the design of institutional arrangements and the choice of financial services to be offered to different target groups.

The research emanating from this program was published during 1996–98 in a number of reports and papers disseminated by IFPRI and the Bunda College of Agriculture, following an October 1996 workshop held at the college at which the major

research results were shared and discussed with policymakers, microfinance practitioners, and researchers. This research report presents an in-depth analysis addressing the research objectives described.

The study analyzed the determinants of access to formal and informal credit and the demand for loans. It found that formal lenders in Malawi—such as rural banks, savings and credit cooperatives, and special credit programs supported by the government and nongovernmental organizations—prefer to give loans to households with diversified asset portfolios and therefore more diversified incomes. This is presumably done to increase and stabilize repayment rates. It also found that households in Malawi are generally credit constrained in both the formal and informal sectors of the credit market. For example, close to half of the households participating in formal credit programs still have binding credit constraints. However, Malawian households would borrow on average only about half the amount of any increase in their credit limits.

The level of interest rates charged on loans seems not to be an important factor for households in deciding in which microfinance institution to participate. Nonprice attributes of credit institutions and their services play a larger role. These attributes include the types of loans provided and the restrictions on their use, as well as the types of nonfinancial services provided by the programs, such as training in the management of microenterprises. This result suggests that the acceptance of an institution by its clientele, and therefore its prospects for growth and sustainability, are determined by a range of characteristics of both its financial and its nonfinancial services.

The main findings of the study regarding the impact of access to credit on household welfare outcomes do not support the notion that improving access to microcredit is always a potent means for alleviating poverty—an opinion voiced, for example, at the Microcredit Summit in Washington, D.C., in February 1997. Both the tabular and the econometric analysis shows that when households choose to borrow they realize lower net crop incomes than nonborrowers. Although this result is not statistically significant, it nonetheless points out the risk of borrowing: that borrowers can be worse off after repaying the principal and interest.

Two main reasons for the negative (albeit insignificant) relationship between borrowing and net crop incomes are identified. Both have important implications for financial sector policy and the conduct of rural financial institutions in Malawi. The first reason is the focus of the loan portfolio on one loan product, which provides farmers too much costly fertilizer for hybrid maize. Three of the four institutions investigated in this study provided agricultural credit, focusing mainly on an input package for hybrid maize. The second reason is the below-average rainfall in the two survey years and the concentration of the loan portfolios of the formal lenders on maize, a drought-sensitive crop.

Consistent with the insignificant results for crop income, we find no significant impact of access to credit on the per capita incomes, food security, and nutritional status of credit program members. As the credit services of the formal institutions are mostly geared toward income generation, and in particular toward the growing

of fertilized hybrid maize and tobacco, access to the type of credit products offered in Malawi is expected to have mostly indirect effects on consumption and nutrition through its potential effect on income. The rural financial institutions in Malawi covered in this study do not offer financial products, such as consumption credit and precautionary savings options, that could eventually have a direct effect on consumption or on nutritional status.

Growing tobacco is found to be the most important determinant of household crop income. Another finding of the study, however, is the fact that households that grow tobacco are less food secure, with significantly lower per capita daily calorie intake and a higher prevalence of both chronic and acute malnutrition compared with households that do not. The food insecurity and malnutrition of tobacco households may be traced to the combination of larger than average household sizes because of the labor-intensive nature of tobacco growing and the high relative cost of buying maize for consumption.

The study also found that the price of maize has a significant and negative direct impact on household per capita calorie intake, while its indirect effect on the latter through household income is positive but statistically insignificant. This finding is consistent with two other findings of the study: that the marginal impact of the price of maize on household income, although sizable, is not statistically different from zero and that smallholder farmers in Malawi are, on average, net buyers of maize because of their 59 percent average maize self-sufficiency. Therefore any increase in the price of maize is likely to have a negative impact on the food security of the average smallholder farm household.

A major conclusion of this study is that the contribution of rural microfinance institutions to the income of smallholders can be limited or outright negative if the design of the institutions and their services does not take into account the constraints on and demands of their clients. Developing attractive credit services requires both identifying farm and nonfarm enterprises and technologies that are profitable under the conditions experienced by subsistence-oriented farmers and responding to the numerous constraints of resource-poor rural households. The results suggest that a strategy of expanding financial institutions in rural, drought-prone areas with inadequate market and other infrastructure may—at least in below-average rainfall years—have no significant positive welfare effects. The risk of drought in Malawi, as in much of rainfed Sub-Saharan Africa and other countries, constitutes a considerable challenge for developing sustainable rural financial institutions. In such environments, a strategy providing for greater diversification of the portfolio of assets and liabilities of the rural financial institutions, as well as adequate provisions for loan defaults and the building up of reserves for rescheduling loans, is a necessary precondition for rural financial institutions to prosper and to be able to offer their clientele reliable access to future credit and savings services.

The necessary resources, infrastructure, and socioeconomic environment are not yet in place for access to formal credit to realize its full potential benefits for Malawi's rural population. Therefore—considering that the formation of sustainable rural financial institutions is a difficult task to achieve in rural economies that lack

irrigation, exhibit insufficient hard and soft infrastructure, and support a poorly educated rural population adversely affected by malnutrition and disease, and considering that the benefits at the household level may not materialize in drought years—the report recommends a cautious and gradual strategy for expansion of rural financial institutions in Malawi. This strategy would require direct support by the state through an adequate legal and regulatory framework, through the support of institutional innovations and pilot programs in rural areas that may have the potential to reduce transaction costs in providing savings, credit, and insurance services to rural clientele.

Adoption of a cautious strategy would also imply that the formation and initial expansion of rural financial institutions should focus on high-potential agricultural areas that allow for lending to those growing a diversified array of cash and food crops as well as offering financial services for off-farm enterprises at low transaction costs. This does not mean that low-potential and drought-prone agricultural areas should be neglected, because credit may be the best or only option for the smallholder farmers to finance their input acquisitions after experiencing a crop failure. Indeed the evidence showed that without access to credit the ability of smallholder farmers to recover from a crop failure is extremely limited. The mere knowledge that credit will be available in case of crop failure can be beneficial to poor farmers by inducing them to adopt new and more risky but potentially profitable crops or technologies. The econometric analysis has confirmed the positive and quite sizable (though not statistically significant) impact of merely having the option to borrow, even if it is not exercised. However, the expansion of microfinance into marginal areas with insufficient market and other infrastructure should be coupled with a greater emphasis on other growth- and welfare-enhancing investments (such as those in transport, health, and communications infrastructure) and with targeted safety-net interventions for the very poor.

In summary, the benefits of access to credit for smallholder farmers depend on a range of agroecological and socioeconomic factors, some of which are time-variant and subject to shocks such as drought. Access to credit is therefore no panacea for poverty alleviation. The full potential of credit access in increasing the welfare of the poor can only be realized if coupled with adequate investments in hard and soft infrastructure as well as investments in human capital.

CHAPTER 1

Introduction

As is the case in many African countries, the majority of smallholders in Malawi are left out of the rural financial system. These households, characterized by average landholdings of less than 1 hectare, do not grow enough food to feed themselves even though they concentrate almost exclusively on the production of maize, the major staple food in Malawi. Consequently, as land is a binding constraint in most areas of Malawi, increases in agricultural productivity, in particular in the growing of maize, and increased diversification into other food and cash crops as well as nonfarm enterprises are key requirements for poverty alleviation. Such changes in the production and consumption strategies of households require capital, and they are risky to implement for households that produce maize for subsistence with low-input, low-output technology in a highly drought-prone environment.

It has been argued that most of Malawi's smallholder farmers are too poor to be able to benefit from any kind of access to credit, and that, even if they had access to adequate credit and inputs, their land constraints are so severe that any increase in productivity would still fall short of guaranteeing their food security (Government of Malawi 1995). For these households, credit for nonfarm income-generating activities has been suggested as a policy alternative to address their food insecurity and malnutrition. To gain a better understanding of the possible role of credit in improving income and household food security and in alleviating poverty in Malawi, in November 1994 the International Food Policy Research Institute (IFPRI) and the Department of Rural Development (DRD) of the Bunda College of Agriculture, University of Malawi, initiated a research program on rural financial markets and household food security in Malawi. The objectives of the research program were to study the determinants of access to and participation in existing formal and informal credit and saving systems, and to analyze the effects of household access to credit on agricultural productivity, income generation, and food security. This report presents the major results of that research project.

The Potential Contribution of Improved Access to Formal Credit in Poverty Alleviation

It is generally agreed among researchers and policymakers that poor rural households in developing countries lack adequate *access to credit.* This lack of adequate access to credit is in turn believed to have significant negative consequences for various aggregate and household-level outcomes, including technology adoption, agricultural productivity, food security, nutrition, health, and overall household welfare.

Access to credit affects household welfare outcomes through three pathways (Zeller et al. 1997). The first pathway is through the alleviation of the capital constraints on agricultural households: expenditures on agricultural inputs and on food and essential nonfood items are incurred during the planting and vegetative growth periods of crops, whereas returns are received only after the crops are harvested several months later. Most farm households show a negative cash flow during the planting season. Therefore, to finance the purchase of essential consumption and production inputs, the farm household must either dip into its savings or obtain credit. Access to credit can therefore significantly increase the ability of poor households with little or no savings to acquire agricultural inputs. Furthermore, easing potential capital constraints through the granting of credit reduces the opportunity costs of capital-intensive assets relative to family labor, thus encouraging the adoption of labor-saving, higher-yielding technologies and therefore increasing land and labor productivity, a crucial factor in encouraging development, in particular in many African countries (Delgado 1995; Zeller et al. 1997).

The second pathway through which access to credit affects household welfare is by increasing a household's risk-bearing ability and by altering its risk-coping strategy. The third pathway—enabling access to credit for consumption smoothing—is closely linked to the second, and we therefore discuss them together because they both affect the resilience of households in bearing production and consumption risks. The mere knowledge that credit will be available to cushion consumption against an income shortfall if a potentially profitable, but risky, investment should turn out badly may induce a household to bear the additional risk. The household may therefore be willing to adopt new, riskier technologies (Eswaran and Kotwal 1990). A household may also benefit from mere access to credit even if it is not borrowing, because with the option of borrowing it can avoid adopting such risk-reducing but costly strategies as the production of low-risk but less profitable food crops, such as local maize and cassava, and the accumulation of assets that mainly serve precautionary savings purposes but that may yield very poor or even negative returns (for example, keeping cattle or cash).

Most rural financial sector strategies gave due recognition to the first pathway but often neglected or completely ignored the other two. The vast majority of credit programs provided in-kind production credit at subsidized interest rates. And most of them failed both to serve the rural poor and to remain sustainable credit institutions (Adams, Graham, and von Pischke 1984; Adams and Vogel 1986; Braverman and Guasch 1986). For example, the agricultural credit system in Malawi used to be a

prime example within Africa of a successful government-supported credit program because it was enjoying average repayment rates of over 97 percent from 1968 to 1991. The system collapsed in 1992 owing to a combination of severe drought and political liberalization that caused the repayment rate to plummet to less than 25 percent (Msukwa et al. 1994; Murotho and Kumwenda 1996).

In response to these failures and recognizing that traditional commercial banks typically have no interest in lending to poor rural households because of their lack of viable collateral and the high transaction costs associated with the small loans that are best suited to them, innovative credit delivery systems are being promoted throughout the developing world as a more efficient way of improving rural households' access to formal credit. Unlike commercial banks, these credit programs have as their guiding principles not profit but rather accessibility and sustainability. Many of them are group-based lending programs relying on joint liability and peer pressure as substitutes for collateral, along with community-based delivery systems that seek to exploit the social capital and information advantages of local communities in screening and monitoring borrowers. The Grameen Bank in Bangladesh is a well-known example with a proven record of reaching the poorest and simultaneously achieving very high repayment rates.

Policy Relevance and Objectives of the Research

Community- and member-based microfinance programs have enjoyed considerable political and financial support since the 1990s. Three basic premises explain the renaissance of "rural credit"; the first is relatively recent, but the other two are deeply rooted within development theory and strategy:

1. Member-based financial institutions have an advantage in transaction costs over traditional forms of banking characterized by reliance on land collateral and a large amount of paperwork. This perceived cost advantage can allow innovative rural financial institutions to become financially sustainable in the long run. Initial subsidies by the state are deemed justified and are required to finance the development of the institution and to allow it to achieve a scale at which it can cover its costs on its own.
2. With improved access to credit, poor rural households will be able to engage in more productive farm and nonfarm income-generating activities to raise their living standards.
3. The aggregate social benefits outweigh the opportunity costs of the public funds used for developing rural financial institutions.

The research presented in this report focuses only on the investigation of the second premise. It addresses a number of questions related to the provision of institutional credit in the context of rainfed agriculture and poor market infrastructure: Do households who participate in credit programs improve their living conditions? If they do, in what ways does improved access to formal credit benefit these households? In particular, does access to formal credit contribute to raising farm and off-farm income and household food security? For the particularly poor and disadvan-

taged among the rural population, such as women (who are the target group of some of these programs), does access to formal credit contribute to the desired goal of poverty reduction?

Quantifying the impact of improved access to formal credit on different groups of households is important for policy purposes for at least two reasons. First, it can serve as guide for the allocation of scarce resources to the numerous development programs competing for the same funds. Second, it establishes the relative importance of the various factors that permit certain households in a given socioeconomic environment to achieve greater benefits from access to formal credit than others (Zeller and Sharma 1998).

Furthermore, despite the increasing importance of microcredit programs in developing countries, most rural households continue to rely on the informal credit market for their intertemporal transfer of resources. They rely on complex strategies to increase their productive capacity, share risk, and smooth consumption over their life cycles. These strategies generally work through self-enforcing informal contracts among friends, neighbors, and members of extended families, and they are arranged within networks of informal institutions of diverse types (Fafchamps 1992; Coate and Ravallion 1993; Udry 1994, 1995b; Lund and Fafchamps 1997). One hypothesis often advanced by researchers and policymakers is that government- and nongovernmental organization (NGO)–supported credit programs may crowd out the financial services offered by these informal financial institutions. Therefore understanding how the informal institutions serve households' demand for financial services and interact with the formal credit institutions set up by governments and NGOs is critical in identifying policies, institutional designs, and financial services that can expand and complement rather than substitute for the services offered by the existing informal credit market. An important step in obtaining this information is to quantify the extent and determinants of households' access to both informal and formal credit markets and the degree to which the two forms of credit are complements or substitutes.

A Definition of Access to Credit

Access to formal credit is often confused with participation in formal credit programs. Indeed the two concepts are used interchangeably in many studies. However, to analyze satisfactorily the socioeconomic determinants of both access to credit and participation in formal credit programs and to assess their respective impacts on household welfare outcomes, one needs to make the distinction between *access to credit* (formal or informal), *participation* in formal credit programs or in the informal credit market, and being *credit constrained.*

A household has *access* to a particular source of credit if it is *able* to borrow from that source, although for a variety of reasons it may choose not to. The extent of access to credit is measured by the maximum amount a household can borrow (its credit limit). If this amount is positive, the household is said to have access. A household is said to be *participating* if it is borrowing from a source of credit. A household is

credit constrained when it lacks access to credit or cannot borrow as much as it wants. These distinctions are particularly important because, as discussed previously, a household living in a risky environment may benefit from mere access to credit even if it is not actually borrowing.

Structure of the Report

Chapter 2 gives a brief general description of the rural economy and the agricultural policy environment. The main part of this chapter describes the credit programs studied. Chapter 3 covers the survey design and provides a descriptive and tabular analysis of the socioeconomic characteristics and behavioral and welfare outcomes of the households surveyed. This tabular analysis provides some indications of the effects of access to credit on the outcomes studied, but of course it falls short of providing statistically tested measurements. The chapter serves mainly to describe the observed outcomes and to disaggregate them according to membership in particular credit programs and other socioeconomic characteristics. Chapter 4 describes the structure of the econometric model and presents the estimation procedure that we use to measure access to credit and its effects on household welfare outcomes. Chapter 5 discusses the results of the econometric analysis of the determinants of households' access to and participation in informal and formal credit markets, as well as the marginal impacts of access to formal credit on farm and nonfarm incomes, household food security, and nutritional status. Chapter 6 considers implications for policy and future research.

CHAPTER 2

The Rural Economy and Microfinance Institutions in Malawi

This chapter briefly outlines the main features of the rural economy and recent changes in the agricultural policy environment. It then describes the credit programs studied.

The Rural Economy and Recent Policy Changes in Malawi

Rural poverty in Malawi is pervasive (United Nations and Government of Malawi 1993). The country's nominal per capita income level of US$140 in 1994 is one of the lowest in the world. Forty percent of gross domestic product and about 75 percent of export earnings were accounted for by the agricultural sector during 1989–94 (IMF 1995). About 90 percent of the population of 11 million lives in rural areas, and it is predominantly employed in small-scale farming activities (Chilowa and Chirwa 1997). Farms are very small. Seventy-two percent of smallholder farms cultivate less than 1 ha (World Bank 1995). A single rainy season with erratic rainfalls, coupled with a virtual absence of irrigation, makes crop production very risky. Malawi suffered two major droughts during the 1990s, one in 1991/92 and one in 1993/94, followed by a below-average maize crop in 1994/95. The latter two years were the recall periods for crop income in the DRD/IFPRI survey. The Government of Malawi identifies drought risk as one of the major reasons for farmers' failure to adopt agricultural innovations, as the profitability of these varies markedly with rainfall (Government of Malawi 1995a).

The Dualistic Structure of the Rural Economy in Malawi

The rural economy in Malawi is characterized by the coexistence of estate and smallholder agriculture. Land cultivated by estates is privately owned (freehold land) or leased from the state on long-term leases for 99 years (leasehold land). Land culti-

vated by smallholders is governed by customary laws that provide the farmer with user rights. These rights can be passed on to children, and only in exceptional cases do they deny traditional authorities the inheritance of user rights. The estate sector is characterized by relatively capital-intensive production that concentrates on lucrative export crops, such as tobacco, sugar, tea, and cotton. In contrast, the smallholder sector is to a large extent oriented toward subsistence production. It employs and feeds most of the rural population. The share of land cultivated by estates has increased since independence in 1964, and it reached about 12 percent of the total arable area in the early 1990s (Harvard Institute for International Development 1994a,b). This trend was largely due to a policy framework that favored the estate sector over the smallholder sector, in particular the policy that only estates were allowed to grow tobacco, the major and most lucrative export crop of Malawi.

Recent Reforms in Agricultural Policy

Past policies in Malawi by and large favored the production of high-value cash crops in the estate sector while the smallholder sector was encouraged to produce and sell maize, the country's food staple, through official market channels (Mtawali 1993). Economic and agricultural growth in the 1960s and 1970s was driven mainly by a prospering and expanding estate sector; however, external shocks, such as the disruption of trade routes and deteriorating terms of trade during the late 1970s, led to a decline in gross domestic product and a serious economic crisis during the early 1980s. These problems also reflected basic structural weaknesses and policy distortions in the economy that could be attributed to an inefficient production sector, resulting from price controls and massive direct interventions by government in agricultural input and output markets that favored the estate over the smallholder sector.

Since the early 1980s the Government of Malawi has gradually addressed these policy distortions (Kherallah and Govindan 1997). However, major changes directly affecting the smallholder agricultural sector were implemented only cautiously, beginning with the liberalization of output markets during 1987–93, the dismantling of credit subsidies in 1993/94, the abolition of fertilizer subsidies in 1995, and the gradual relaxation of the tobacco quota system that eventually allowed smallholders (in 1996/97) to produce and market tobacco without any restrictions for the first time.

Developments in Smallholder Maize and Tobacco Production during the 1990s

Maize is the major food and crop in Malawi. Tobacco is the major cash and export crop. The reforms enacted during the 1990s brought about significant changes in the production of these crops by smallholders (Chilima, Chulu, and Mataya 1998). Tobacco and hybrid maize are also the major crops for which agricultural credit has been given in Malawi during the 1990s. The recent developments in the two sectors therefore have a direct bearing on the effect of access to credit on farm income.

High (but Recently Declining) Reliance on Maize

During the 1980s about three-quarters of smallholders' acreage was planted to maize. This share declined somewhat during the 1990s. Other food crops include cassava, sweet potatoes, groundnuts, and rice. Many of the two million smallholder households are chronically food deficient because of small farm size and low yields of the dominant local maize varieties. About 50 percent of smallholder households are food insecure, and 60 percent of the rural and 65 percent of the urban population earn incomes below the poverty line of US$40 per capita per year (Government of Malawi 1994a).

Although the objective of macroeconomic reform and the liberalization of agricultural and financial markets was to reduce discrimination against the smallholder agricultural sector and to provide more opportunities for diversification of rural incomes, until 1992/93 the agricultural credit, input, and extension policy continued to focus on the dissemination of a fixed input package of hybrid maize seed and fertilizer that was delivered at subsidized interest rates and input prices to smallholders.

The policy of massive distribution of maize credit to smallholders was successful in increasing the share of higher-yielding hybrid maize in total smallholder hectarage planted to maize from about 8 percent in 1985 to 25 percent in 1992, while the overall share of maize in smallholder acreage increased from 73 percent to 80 percent. However, the concentration of the loan portfolio on one drought-sensitive crop, combined with the droughts in 1992 and political promises to write off loan debt during the election year, led to widespread loan defaults and eventually to the collapse of the parastatal Smallholder Agricultural Credit Administration (SACA) in 1994. Although 400,000 farmers received credit in 1992, only 34,000 did so in 1994, from the newly formed Malawi Rural Finance Company (MRFC), a state-owned financial institution that seeks to offer agricultural credit on a national scale.

Following the major drought in 1992, the share of smallholder hectarage planted to nonmaize crops, in particular cassava and pulses, increased. Farmers' response to the perceived advantages of drought-resistant crops, the sudden collapse of the public system for distributing credit for maize production, and the policy reorientation toward diversifying smallholder crop production may all have played a role in this. Following a second drought in 1993/94, large-scale distribution of free fertilizer and hybrid maize seed to drought-affected areas during 1994/95 and 1995/96 seems to have contributed to a revival of hybrid maize in smallholder farms despite the unfavorable ratio between maize price and fertilizer price after the abolition of fertilizer subsidies in 1995 and the devaluation of the Malawi kwacha during 1994/95 by about 300 percent. However, as Chilima, Chulu, and Mataya (1998) point out in their analysis of smallholder maize production, the area cultivated under drought-prone maize is slowly losing ground as the hectarage planted to more lucrative crops (mainly tobacco) and more drought-resistant crops (such as cassava) expands.

The Booming Smallholder Tobacco Sector

From the time that Malawi achieved independence until the early 1990s, smallholders cultivating customary land were squeezed out of the lucrative export market in tobacco by a particular set of policies. The Special Crops Act of the Government of Malawi allowed for cultivation of tobacco and other export crops only on leasehold and freehold land (Sahn and Arulpragasam 1993; Sijm 1997). The production of burley and flue-cured tobacco on customary smallholder land was illegal until 1990. Moreover, the system of allocation of tobacco production quotas to estates created economic rents for the powerful landed elite and reinforced the will of political forces to safeguard the country's dualistic agricultural structure.

In 1990 the Government of Malawi initiated a policy of gradual liberalization of the tobacco subsector in order to mitigate the structural constraints that had for so long prevented smallholders from contributing to and earning their share from the overall development of the agricultural sector. The production of burley tobacco by smallholders on customary land was first permitted on a pilot basis during the 1990/91 growing season, when a total of 7,600 growers were registered to grow burley tobacco with a quota of 3.0 million kilograms. Quantities allocated to each grower were limited to a maximum of 300 kilograms. Smallholder tobacco had to be sold initially to the Agricultural Development and Marketing Corporation (ADMARC), a parastatal, at below-market prices. The evident success of the pilot scheme, combined with the democratic election of a new government and the related review of all policies implemented during the past three decades, led to a gradual increase of the quota allocated to smallholders. By 1996 the size of the smallholder quota had increased more than tenfold from its initial level.

In view of the success of the tobacco market reforms in encouraging widespread participation of smallholders in direct competition with the estates, the Government of Malawi repealed the Special Crops Act in 1996 and opened up the production of burley tobacco to any grower in Malawi, regardless of whether or not he or she was formally registered to produce the crop. The repeal abolished the system of production quotas and special marketing rights, and thereby eliminated the rents of the estates that for decades had benefited from them.

Rural Microfinance Institutions in Malawi

In common with many other developing countries, Malawi has over the past few years seen the emergence of various rural credit programs. The four that are the focus of this research are MRFC, a state-owned and nationwide agricultural credit program; Promotion of Micro-Enterprises for Rural Women (PMERW), a microcredit program targeted at women in support of nonfarm income-generating activities; the Malawi Mudzi Fund (MMF), a replica of the Grameen Bank; and the Malawi Union of Savings and Credit Cooperatives (MUSCCO), a union of locally

based savings and credit associations. Except for MUSCCO, all programs rely on group lending.[1]

There are numerous other small credit programs run by various national and international NGOs, which are often—but not always—implemented in collaboration with a Malawi government institution (see Evans 1993, or more recently Chirwa et al. 1996). However, of all these credit programs, only MRFC and MUSCCO can claim to have national coverage. All the other programs operate in a few districts and, in general, in conjunction with other noncredit developmental programs (Evans 1987, 1993; Government of Malawi 1994b).

In the research, we have focused on these four microfinance institutions as representative of the spectrum of formal credit and savings options available to rural households in Malawi. Furthermore, the structures, target clienteles, rules, and types of loans of the four microfinance institutions are different enough to allow for a comparative study of the effects of alternative design characteristics on their performance in terms of participation and effects on the livelihood of their clienteles.

Malawi Rural Finance Company (MRFC)

MRFC is a recent creation of the Government of Malawi, with funding from the World Bank, following the collapse of SACA. SACA was a department of the Ministry of Agriculture that had provided seasonal agricultural loans to smallholder farmers since its establishment in 1987 (on the history, operations, and performance of SACA, see Murotho and Kumwenda 1996).

Although MRFC inherited the operations of SACA in October 1994 and absorbed many of its staff, MRFC seeks to operate under commercial principles under a board of directors independent of the Government of Malawi. In fact plans call for the company eventually to be privatized and transformed into a licensed rural bank (World Bank 1993; Government of Malawi 1994b). Apart from its portfolio of loans to estates, the target clientele of MRFC is smallholder farmers organized into joint liability credit groups of 5 to 10 members. MRFC provides mostly in-kind seasonal agricultural loans for seed, fertilizer, and pesticides for hybrid maize and tobacco. It also offers short-term (two-year) and medium-term (five-year) loans for farm equipment, although these services play a negligible role in its overall loan portfolio to smallholders.

The DRD/IFPRI survey data cover the 1993/94 and 1994/95 seasons. As such, most of the smallholder loans from MRFC in our sample are for hybrid maize and relatively few are for tobacco.[2] The data do not capture some of the more recent shifts that MRFC has undertaken to develop credit services for off-farm micro-, small-, and

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[1] PMERW and MMF have since been incorporated into the MRFC.

[2] For example, 50 percent of the chemical fertilizer acquired in 1994/95 by MRFC smallholder customers in our sample was used on hybrid maize, compared with 11 percent used on tobacco and 39 percent used on local maize (see Table 11). Most of the loans may have been for tobacco, but these figures indicate that MRFC smallholder customers diverted most of their loan packages toward their food crops.

medium-scale enterprises in rural areas and its shift away from hybrid maize loans to tobacco loans. The latter shift, according to MRFC, was motivated by the below-average loan repayment rates for hybrid maize loans in 1994/95 and 1995/96. In turn, the low repayment rates appear to be strongly linked to the apparent risk and decline in profitability of hybrid maize production because of the devaluation of the Malawi kwacha and the abolition of fertilizer subsidies in 1994/95. The low profitability of hybrid maize compared with tobacco and the high downside risk of achieving negative gross margins compared with the growing of low-input local maize varieties are also confirmed in the DRD/IFPRI survey data, as will be shown in the next chapter.

During the 1994/95 season MRFC serviced 2,343 credit clubs, made of 81,075 smallholder farmers, and 4,394 estates, for a total of about 35 million Malawi kwacha (MK) and an average loan size of MK 5,600 or approximately US$370 (MRFC 1994, 1995).[3] Table 1 shows that the total amount of loans disbursed by MRFC reached a total value of about MK 241 million in the 1995/96 season before declining to about MK 166 million in the 1996/97 season. The share of the disbursed loans going to tobacco clubs has steadily increased during the three lending seasons: 41 percent in 1994/95, 45 percent in 1995/96, and 47 percent in 1996/97. The share of the loans disbursed to the estates has also experienced similar growth (29 percent, 33 percent, and 43 percent, respectively). In contrast, the share of the loans received by the other clubs (mostly for maize) and individual customers has been declining (31 percent, 22 percent, and 10 percent, respectively).

As a consequence of its adherence to commercial lending practices, MRFC has been charging relatively high interest rates. Indeed its loans carried annual interest rates of 40 percent in 1994/95, 54 percent in 1995/96, and 37 percent in 1996/97. These high rates have been justified by the fact that MRFC obtains its funds at market rates from the Reserve Bank of Malawi and by the inflationary environment that characterized Malawi during these three seasons. The inflation rate, for example, was 83 percent in 1995 (Reserve Bank of Malawi 1996). MRFC's loan recovery rate in 1994/95 was good (95 percent), but it deteriorated sharply in 1995/96 (76 percent) before rising again in 1996/97 (87 percent). The sharp increase in the size of the loan portfolio in the 1995/96 season likely played a role in the deterioration that year of the recovery rate, which, as shown in Table 1, was due to some extent to the very low recovery rate of the loans given to the other clubs (about 54 percent compared with about 91 percent in 1994/95). The 1995/96 recovery rates for tobacco clubs (82 percent) and the estates (84 percent) were also significantly lower than those in 1994/95 (96 percent and 98 percent, respectively).[4] The loan recovery rate has improved in 1996/97 for all cases (92 percent, 84 percent, and 82 percent, respectively). Accord-

[3] The exchange rate was US$1 for MK 15 in 1995. The average loan size for a smallholder farmer is much smaller than the figure given because the loan is for the whole group.

[4] When we adjust for their respective shares of the loan portfolio, tobacco clubs, estates, and other clubs are responsible for, respectively, 33 percent, 24 percent, and 43 percent of the 20 percent decline in the overall loan recovery rate (from 95 percent to 76 percent).

Table 1—Loan disbursements and recovery rates of the Malawi Rural Finance Company

Type of borrowers	Number of borrowers			Total amount of loans disbursed			Percentage credit recovered		
	1994/95	1995/96	1996/97	1994/95	1995/96	1996/97	1994/95	1995/96	1996/97
				(1,000 MK)[a]			(percent)		
Total	6,207	13,946	11,003	34,941	240,882	166,203	95.13	76.29	87.16
Tobacco clubs[b]	1,407	3,476	2,968	14,452 (41%)	107,491 (45%)	77,638 (47%)	96.24	81.74	91.71
Estates	3,305	7,931	6,424	10,243 (29%)	80,383 (33%)	71,532 (43%)	98.02	83.63	83.50
Other clubs[b] and entities	1,495	2,539	1,611	10,245 (31%)	53,008 (22%)	17,032 (10%)	90.69	54.11	81.82

Source: Malawi Rural Finance Company internal documents (various issues).

[a] The exchange rate was 1 U.S. dollar for 15 Malawi kwacha (MK) in 1995. The share of the total amount disbursed is in parentheses.

[b] Each club has on average between 15 and 20 smallholder members who share a single loan issued to the club. Most of the credit clubs are either tobacco or maize clubs.

ing to its internal records, the company earned profits from its lending in all lending seasons (MRFC *Corporate profile* 1998).

Malawi Mudzi Fund (MMF)

MMF was created in 1987 as a pilot credit program and a separate component of the World Bank–funded agricultural credit project that also supported SACA. The component for MMF has been supported by the International Fund for Agricultural Development (IFAD). Its design was guided by the experience of the Grameen Bank in Bangladesh.

The objective of the MMF was to provide loans for nonfarm income-generating activities to poor rural households with less than 1 hectare of land in two districts of Malawi (Chiradzulu and Mangochi) during a pilot phase of five years (World Bank 1987). From the start of its lending operations in 1990 to April 1995 (the point at which it was absorbed by MRFC), MMF granted 2,676 loans. The mostly female borrowers (95 percent of the loans) were organized into 561 credit groups, each with five members. The members were held individually and jointly responsible for the repayment of all loans obtained by those in the group. A cumulative total of MK 841,000 was disbursed by MMF, with an average loan size of MK 300 or US$20 (Murotho and Kumwenda 1996). Most of the MMF loans were given for the sale of produce (fish, maize, beans, and so forth) and other small-scale trading activities. Few loans were given for crop production, and of those most were for growing hybrid maize (MMF 1994).

In the first two years of its operation MMF was lending to both male and female borrowers. A very high default rate among male borrowers has since led MMF to concentrate its lending on women only (MMF 1994). Owing to its pilot nature and the close supervision and intensive training afforded credit recipients, MMF has been characterized by high operating costs per borrower served. In April 1995, MMF's operation and groups were incorporated into MRFC. Under MRFC plans call for the MMF program to receive national exposure and become MRFC's tool for reaching the poorest 25 percent in Malawi by providing them with loans for both nonfarm income-generating activities and agricultural production (World Bank 1994; MRFC *Annual report* 1996).

Malawi Union of Savings and Credit Cooperatives (MUSCCO)

MUSCCO is a federation of locally based savings and credit cooperatives (SACCOs). It was created in 1980 with financial and technical support from the United States Agency for International Development (USAID). Its objective is to provide credit and savings options to those low-income people not serviced by commercial banks. This goal was to be achieved by promoting, organizing, and expanding the number and membership of the very few savings and credit cooperatives that existed at that time in Malawi (Reeser et al. 1989). Originally MUSCCO operated only in rural areas, servicing the financial needs of the few relatively better-off farmers. However, in 1985, with the response to its savings products by its rural clientele deemed unsuccessful, it refocused its activities on urban areas. By 1993 160 SACCOs with a total membership of 23,000 were affiliated with MUSCCO. Of these 41 percent are located in urban areas and the remainder in rural towns (Evans 1993).

Following cooperative principles, MUSCCO members buy shares in their respective societies. For a member to qualify for a loan, he or she must have accumulated MK 100 in shares and a minimum of MK 50 in savings (MUSCCO 1994). The loan policies of the SACCO also stipulate that some form of collateral is required before a loan can be given to a member. There were 12,750 borrowers in 1993 (over 80 percent of whom were males) for a total of MK 7 million disbursed. On average the SACCO loans ranged from MK 700 to MK 7,000 (that is, from US$50 to US$500), with a maturity of between one and two years. The loans were used both for agricultural production (43 percent) and for nonfarm income-generating activities (Evans 1993).

The Nafisi SACCO of Dowa, which was selected for this study, was created in 1990, initially capitalized by a US$12,300 grant from the Trickle Up Program of New York. Its members are relatively poor farmers who obtain loans almost exclusively for seasonal agricultural inputs such as fertilizers and seeds (VEZA International 1994). The functioning of the Nafisi SACCO was closely linked to a local NGO, the Hills of Dowa Enterprise Zones Association (HODEZA). This NGO has supported the SACCO through technical assistance and logistical support in its day-to-day operations and in the marketing of its members' maize crop. HODEZA itself is the local counterpart of a Chicago-based NGO called Village Enterprise Zone Associations International.

Promotion of Microenterprises for Rural Women (PMERW) Credit Program

The PMERW credit program was started in 1986 by the Ministry of Women and Children's Affairs and Community Services (MOWCACS) with the technical and financial support of the German Agency for Technical Cooperation (GTZ). The program began as a multiservice developmental project with a small and loosely structured credit component. It introduced small-scale nonfarm income-generating technologies to rural areas and provided business training and technical advice to women organized into group-owned enterprises.

The program was initially targeted to rural poor women with landholdings of less than 0.5 hectare in rural growth centers in Dedza, Mangochi, Nkhotakota, and Rumphi (Evans 1993). The program relied on the cooperation of the district community development officers (DCDO) and community development assistants (CDA) of MOWCACS, who—apart from their other duties—organized and supervised the women's groups and provided them with business training and advice. The CDAs were also in charge of delivering and recovering the loans given individually to the women. Owing to management and operational problems, which resulted mainly from tying credit to developmental interventions, coupled with lax loan delivery and recovery procedures, the credit component did not meet its objectives during the first phase of the project, which ended in 1989 (Zingani 1991; Evans 1993).

Learning from this failed experience, a new and well-structured group-based credit program, separated from the small-scale technology development and business training program, was designed and implemented in 1991 with the help of a Kenyan NGO, the Undugu Society. The society trained the DCDOs and CDAs as trainers in group-based lending and credit management concepts.

This new credit program, identified in this report as PMERW1, is a revolving fund operated by MOWCACS that gives two-year loans of MK 1,000 (approximately US$70) to savings-and-credit clubs, each made up of 10 to 15 poor entrepreneurial women who have completed training courses, conducted by the CDAs, in credit rules, management, and responsibilities.[5] In order to be eligible for the MK 1,000 loan, the savings-and-credit club must have the equivalent of 60 percent of the loan amount in a post office savings account. The MK 1,000 loan is in turn distributed to half of the club's members in smaller loans of two months' maturity not exceeding MK 300 and carrying an annual interest rate of 30 percent. The other half of the club's members must wait until the first half have fully repaid their loans before they are eligible for their own loans. Thus at any time during the two years only half of the club can receive loans. In addition to this peer-pressure device, each member is required to have MK 20 of savings and two guarantors within her group before getting a loan. The individual loans are exclusively for nonfarm income-generating activities that consist mostly of produce selling and beer brewing. It is expected that after

[5] All monetary figures regarding the loans quoted in this section are prior to the October 1994 devaluation of the Malawi kwacha. As a general rule the PMERW program doubled all the amounts given in this section after the devaluation. For example, each savings-and-credit club received a MK 2,000 loan in 1996.

two years the savings-and-credit club would reimburse the MK 1,000 loan and would have generated enough funds through the savings and interest charges on the individual loans to be self-financing thereafter, thus enabling the ministry to lend the released funds to newly formed clubs (PWRA 1993b). At the end of July 1994 there were 34 savings-and-credit clubs operating in Mangochi (13), Nkhotakota (12), and Rumphi (9), with a total of 506 women. At that time, the clubs' repayment rates were over 95 percent. The average amount saved per club was MK 500, and 11 of the 14 clubs that were supposed to pay back their MK 1,000 loans had doubled the initial amounts (Faltermeir 1994).

A second credit program, identified in this report as PMERW2, was started by MOWCACS/GTZ in 1993 in collaboration with the Commercial Bank of Malawi (CBM). The PMERW2 program is made of credit groups with 5 to 10 woman members who are skilled in business activities (PWRA 1993a). The credit groups function more or less like the savings-and-credit clubs except that they receive their loans directly from CBM and the individual members can borrow up to MK 1,000. Credit group members are selected, as part of a loan graduation process, from among those savings-and credit clubs members who have excellent credit and business management skills. Successful women with business investments in the range of MK 300–1,000 and who live in the areas covered by the program can also be admitted as credit group members even if they did not previously belong to a savings-and-credit club. The loans given to credit groups by CBM are guaranteed up to 70 percent by a MOWCACS/GTZ fund maintained in an account at CBM. As of October 1994 there were 28 credit groups operating in the districts of Mangochi (10), Nkhotakota (10), and Rumphi (8), with a total of 280 members (PWRA 1993a, 1995).

CHAPTER 3

Survey Design and Description of the Data

To study the impact of household access to formal credit, one needs a sample containing a sufficient share of households participating in the credit programs operating throughout Malawi. The data used in this study come from a year-long, three-round survey of 404 households in 45 villages in five districts of Malawi where the four microcredit programs studied were operating. Figure 1 shows the location of the survey sites.

Sampling Methodology

The first round of the survey took place in February-April 1995, the second round in July-August 1995, and the last round in November-December 1995. Despite the fact that there are numerous credit programs operating in various parts of the country, credit program participation is still rare, occurring in only very few villages. Out of 4,699 households enumerated in the 45 villages covered in the village census undertaken for the survey, only 12 percent were current members of a credit program. Moreover, the 12 percent figure significantly overstates the likelihood of credit program membership in Malawi because it represents the percentage of membership in villages that are actually hosting the four credit programs studied, and the majority of villages in Malawi do not host any credit program.

The very low density of program participation in Malawi alone rules out straight random sampling at any geographic level above the village level. Since it was necessary to include enough credit program participants for the study, the only feasible alternative was to stratify along the program membership status variable with random selection within each stratum. Thus about half of the sample members were selected from participants in the four credit programs. The second half of the sample was equally divided between past participants (mostly from SACA, the failed government credit program) and households who had never participated in any formal credit program. To correct for the oversampling of credit program participants, the

Figure 1—Location of the DRD/IFPRI Rural Finance Survey sites

summary statistics in the tables have been weighted using the strata population weights from the village census.[6]

Description of the Data

The information collected in the survey included data on household demographics, land tenure, agricultural production, and livestock ownership; asset ownership and transactions; food and nonfood consumption; credit, savings, and gift transactions; wages, self-employment income, and time allocation; and the anthropometric status

[6] See Chapter 4 for the sample selection correction in the econometric analysis.

of preschoolers and their mothers. The agricultural data cover the 1993/94 and 1994/95 seasons.

Given the central importance of the credit limit variable for the methodology of the study, we describe in greater detail how the data for this variable were collected. The rationale behind the procedure described here and the issues involved in the interpretation of the credit limit variable thus collected are discussed in Chapter 4.

The questionnaire on credit and savings was administered to all adult household members (those over 17 years of age) in the sample. In each round respondents were asked the maximum amount they *could* borrow during the recall period from both informal and formal sources of credit.[7] If the respondent was involved in a loan transaction as a borrower, the question was asked for each loan transaction (for both granted and rejected loan demands). In this case the credit limit refers to the time of borrowing and to the lender involved in that particular loan transaction. If the respondent did not ask for any loan, the question was asked separately for formal and informal sources of credit with no reference to particular formal or informal lenders. Respondents who were granted loans were also asked the same general question (that is, with no reference to particular formal or informal lenders) in a way that elicited the credit limit they would face if they wanted further loans, not just from the same lender but from the same sector of the credit market (formal or informal) within which they had previously borrowed. Consequently, for both formal and informal credit, the formal and informal credit limits of each adult household member were obtained in each round, even if the respondent was not involved in any loan transaction.

Several other control questions were used to verify the consistency of the answers given by the respondents to this question. Such control questions included the following: What was their program membership status? If they did receive a loan of the same type, were they given a lesser amount than they had asked for, and, if so, how much had they asked for? Had they asked for a loan and been rejected? Why did they not ask for any (or any further) loans? In addition the enumerators were instructed to use other control questions not included in the questionnaires whenever there seemed to be inconsistencies in a respondent's answers (such as, where could they borrow a given amount). A good deal of time was further spent in the field and in the office checking the consistency of answers to these questions and their relation to answers given on other parts of the questionnaire. As a result of these checks, during the first round of the survey most of the respondents were visited at least twice, in order to verify their answers or clarify some of the apparent inconsistencies in their answers. Most of the inconsistencies occurred during the first days of the survey and resulted from some misunderstanding of a question that was often interpreted by either the enumerator or the respondent as asking about "the maximum you *would like* to borrow." This misunderstanding was resolved by instructing the enumerators to

[7] Loans received prior to October 1994 were also recalled (up to three years prior to the 1994/95 season for formal loans and up to 10 months prior to October 1994 for informal loans of more than MK 100).

explain to respondents, before they answered the question, the difference between the two questions.[8]

Demographic Characteristics of Households

We begin by presenting selected demographic characteristics of sample households. Table 2 shows that 28 percent of the households in the sample are headed by women. This figure is close to the widely cited figure of 30 percent for Malawi as a whole. The table also shows that the average household size in the survey areas is 5 persons, and that it is the same for both male- and female-headed households. However, with an average dependency ratio of 0.5, female-headed households have slightly more dependents than male-headed ones (0.4).[9] The average age of household heads in the sample is 42, with female heads of households being, on average, four years older than male ones (44 versus 40). Some 68 percent of household heads attended primary school, but only 17 percent of them have a primary school diploma. Overall, female household heads tend to have a lower primary school attendance rate compared with male heads (63 percent versus 71 percent).

Table 2 also shows the main occupation of household heads in the sample. Farming dominates as first occupation of most household heads (66 percent). This is true for both male heads and female ones (62 percent and 74 percent, respectively). As separate categories, wage laborer and trader come second as first occupation (8 percent), while all the other self-employment income-generating activities grouped together constitute the first occupation for 10 percent of household heads. However, female household heads are four times more likely than male heads to list trader as their first occupation (16 percent compared with 4 percent). The opposite is true for wage laborer (11 percent of male household heads versus 2 percent of female heads). Only 7 percent of female household heads list household work as their first occupation. More than two-thirds of household heads have a second occupation, but fewer than a quarter of them have a third occupation. Many of those with a third occupation are female household heads doing farming, household work, and trading.

Household Asset Ownership, Composition, and Distribution

Asset ownership is arguably an important determinant of access to credit, especially if creditworthiness is judged on the basis of wealth or landed collateral alone. Land, traditionally the most important form of collateral, has been recognized as one of the major constraints in the agricultural sector of Malawi, one of the most densely populated countries in Africa. Therefore we present data on households' ownership of

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[8] Further details on the survey and the data collection methodology are reported in Diagne, Zeller, and Mataya (1996) and Simtowe and Diagne (1998).

[9] The household dependency ratio was calculated as the ratio of the household population younger than 15 or older than 64 to the household size.

Table 2—Demographic characteristics of households

	Male	Female	All
Sample size	291 (72%)	111 (28%)	402
Household size	5	5	5
Adult equivalent population	3.6	3.6	3.6
Dependency ratio	0.4	0.5	0.4
Mean age of head	40	44	42
		(percent)	
Head attended primary school	71	63	68
Head has primary school diploma	21	10	17
First occupation of head			
Farming	62	74	66
Household work	0	7	3
Wage laborer	11	2	8
Trader	4	16	8
Other self-employment	14	1	10
Student	1	0	0
Unemployed	3	0	2
Other	5	0	3
Second occupation of head			
Farming	37	9	28
Household work	27	13	22
Wage laborer	11	74	32
Trader	5	0	3
Other self-employment	6	3	5
Student	14	2	10
Unemployed	0	0	0
Other	1	0	0
Third occupation of head			
Farming	79	75	78
Household work	2	5	3
Wage laborer	4	7	5
Trader	2	0	1
Other self-employment	4	10	6
Student	6	0	4
Unemployed	2	0	2
Other	2	3	2

Source: DRD/IFPRI Rural Finance Survey.

various types of assets, including land, livestock, farm and nonfarm productive equipment, and other nonproductive assets. Assets classified as nonproductive consist of noncultivable land, buildings, furniture, and household utensils. The intrahousehold distribution of ownership of assets and differences among credit program participants and nonparticipants are also discussed because of their influence on the control and allocation of household income.

Table 3 shows that the average total value of all household assets is approximately MK 6,700 or approximately US$450. The average values of land and livestock are, re-

Table 3—Asset ownership, composition, and distribution

	Male-headed	Female-headed	Total
Sample size	291	111	402
Average value of:		(MK)	
All assets	7,551	4,841	6,681
Land	3,866	2,148	3,306
Productive assets[a]	4,537	3,343	4,154
Livestock (total)	1,440	1,848	1,571
Nonproductive assets[b]	3,014	1,498	2,528
Share of assets held in the form of:		(percent)	
Productive assets	57	58	57
On-farm assets	43	46	44
Livestock	11	12	11
Land	56	59	57
		(hectares)	
Average size of land holdings	1.8	1.4	1.7
Household with:		(percent)	
Less than 0.5 hectare	4	9	6
0.5–1.0 hectare	17	21	18
1–1.5 hectares	24	35	28
1.5–3 hectares	42	30	38
Over 3 hectares	12	5	10
Share of assets owned by:			
Head	82	85	83
Spouse	14	3	11
Joint (head and spouse)	2	. . .	2
Other	2	12	4
Hectares of land owned by:			
Head	76	90	80
Spouse	21	6	17
Joint (head and spouse)	2	0	2
Other	1	4	1
Share of on-farm assets owned by:			
Head	68	92	73
Spouse	27	6	22
Joint (head and spouse)	1	. . .	1
Other	4	2	4
Share of cultivable land owned by:			
Head	63	91	69
Spouse	29	6	24
Joint (head and spouse)	3	0	2
Other	5	2	4
Share of livestock owned by:			
Head	85	73	81
Spouse	3	0	2
Joint (head and spouse)	12	0	7
Other	0	27	10
Share of cattle owned by:			
Head	99	100	99
Spouse	1	0	1
Joint (head and spouse)	0	0	0
Other	0	0	0

Source: DRD/IFPRI Rural Finance Survey.

[a] Noncultivable land, buildings, furniture, and household utensils.

[b] On-farm assets (cultivable land, farm equipment, and oxen) and livestock.

spectively, MK 3,300 and MK 1,600. In total the productive assets, including the ones for off-farm income-generating activities, make up 57 percent of the value of household assets. The on-farm assets (cultivable land, farm equipment, and oxen) and livestock constitute, respectively, 44 percent and 11 percent of the total value of household assets. There are noticeable differences between male- and female-headed households. In particular the total value of all assets is significantly higher for male-headed households (MK 7,600) compared with female-headed ones (MK 4,800). Female-headed households also own noticeably less land than male ones (an average of 1.4 hectares versus 1.8 hectares, respectively). Overall, land is very scarce; more than half of all households in the survey areas (52 percent) have landholdings of less than 1.5 hectares.

With regard to the intrahousehold ownership of assets, Table 3 shows that household heads own more than 80 percent of the total value of all household assets compared with only 11 percent for spouses. The disaggregated figures show that, on average, 80 percent of households' land is owned by the household heads. Spouses own only 17 percent of land, and only 2 percent of land is jointly owned by heads and their spouses. Overall, spouses own 22 percent of households' on-farm assets, with their shares for the different types of household assets being highest for cultivable land (24 percent). On the other hand, they own, on average, only 2 percent of the value of household livestock.[10] The intrahousehold distributions of other household assets show more or less the same pattern as that for land.

Table 4 differentiates the household asset ownership by participation in credit programs. The average total value of household assets of current credit program participants (MK 13,000) is more than twice the values for past participants and nonparticipants, which are about MK 5,000. Nonparticipants also have noticeably lower average landholding sizes (1.4 hectares) compared with current participants (2.3 hectares) and past participants (1.9 hectares). Moreover, 31 percent of nonparticipants have landholdings of less than 1 hectare. However, household members of PMERW and MMF are noticeably more likely to have landholdings of less than 1 hectare (about 20 percent of members) than those of MRFC (3 percent of members) or of MUSCCO (10 percent of members). Hence, even if their members are relatively wealthy in terms of assets compared with nonparticipants, these two programs still have the highest proportion of landless among the programs studied.

Table 4 also shows that land ownership tends to be more evenly distributed between heads and spouses in MRFC member households than in households belonging to any one of the other groups (including past participants and nonparticipants). Heads and spouses of MRFC member households own, respectively, 50 percent and 43 percent of household total land, whereas in the other programs and for nonparticipants spouses own no more than 22 percent. In all cases joint ownership of land does not exceed 4 percent except for PMERW1 members, for whom it reaches 16 percent. In MRFC member households spouses own even significantly more cul-

[10] The livestock ownership figures reflect cultural practices preventing women from owning cattle. Indeed virtually all the cattle in male-headed households (99 percent) are owned by heads, and female-headed households have virtually no cattle, although in terms of value they have more livestock (mostly poultry) than male-headed households.

tivable land and on-farm assets than their husbands (53 percent and 50 percent, respectively, for spouses versus 29 percent and 35 percent, respectively, for the husbands). MMF member spouses in male-headed households also own up to 41 percent of their households' cultivable land and value of on-farm assets. On the other hand, PMERW2 member spouses have the lowest shares of cultivable land (4 percent) and value of on-farm assets (4 percent).

Three main conclusions can be drawn from the discussion of descriptive statistics for asset ownership:

1. Even when credit is targeted to the poorest segment of rural households—the approach taken in theory by the PMERW1 and MMF programs—the value of household assets and household landholding size seem to be positively correlated with participation in formal credit programs.
2. The intrahousehold ownership distribution of assets, especially with regard to land, confirms the widespread belief that women in general are in a very weak position in terms of control of household resources. Furthermore, since land is the most common asset pledged as collateral for credit (when it is required), one can conclude from these figures that women's access to credit may strongly depend on the will and priorities of their husbands. Therefore PMERW, and to a lesser extent MMF, seem to have given access to credit to a class of women living in relatively wealthy households in terms of assets compared with nonparticipants, but who are in a very weak position in terms of control of their households' resources. By providing loans for only nonfarm income-generating activities, the two programs are focusing on investment opportunities that are appropriate for their target clientele.
3. The apparent gender differences in the membership composition of MRFC and the MUSCCO-affiliated Nafisi SACCO of Dowa (38 percent and 3 percent of whose members, respectively, are women), both providing almost exclusively seasonal agricultural loans, seem to be the result of the significant differences in the intrahousehold land distribution figures between the two programs. Hence, by giving out loans exclusively for agricultural production purposes in an area characterized by a very unequal distribution of land between male heads of households and their spouses, the Nafisi SACCO is de facto discriminating against women.

Structure of the Formal and Informal Credit Markets in Malawi

In this section we present evidence on the level of rural households' access to formal and informal credit in Malawi. As discussed in the introduction, the credit limit is used to assess the extent of that access as well as the proportion of households having a binding credit constraint. Before presenting evidence on the level of access, we describe briefly the structure of the formal and informal credit markets and some of the main attributes of the loan transactions recorded. The analysis distinguishes the formal and the informal sectors of the credit market because they provide different types of credit services. The formal sector comprises the government- and NGO-supported

Table 4—Asset ownership, composition, and distribution by credit program membership

	Current members							Past members	Never been members
	MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All		
Sample size	86	32	29	62	37	15	231	65	106
Average value of:				(MK)					
All assets	14,379	15,720	7,094	14,075	16,704	32,238	13,168	5,096	4,987
Land	9,578	8,213	3,263	7,974	6,616	35,733	7,840	2,857	1,919
Livestock (total)	1,381	169	1,539	3,120	3,861	2,399	1,720	1,199	1,608
Productive assets[a]	7,936	7,003	4,861	6,806	9,875	17,125	7,454	3,442	3,270
Nonproductive assets[b]	6,443	8,717	2,233	7,269	6,829	15,113	5,715	1,654	1,717
Share of assets held in the form of:				(percent)					
Productive assets	58	42	68	53	54	53	58	65	55
On-farm assets	40	32	52	37	32	39	41	49	44
Livestock	15	1	15	15	16	13	14	14	9
Land	54	61	60	61	43	58	54	60	57
				(hectares)					
Average	2.5	2.3	2.2	1.9	2.6	3.6	2.3	1.9	1.4
Household with size of landholdings:				(percent)					
Less than 0.5 hectare	0	6	0	0	13	1	2	1	8
0.5–1.0 hectare	3	14	10	23	6	20	8	14	23
1.0–1.5 hectare	34	11	22	22	26	14	32	29	26
1.5–3 hectares	28	36	51	40	27	43	32	47	38
Over 3 hectares	36	33	17	16	28	21	27	9	5
Share of assets owned by:									
Head	69	81	94	66	81	49	71	84	93
Spouse	21	18	6	7	10	29	21	16	7

Joint (head and spouse)	4	0	1	26	9	10	4	. . .	0
Other	5	0	0	0	0	12	4	0	0
Hectares of land owned by:									
Head	50	75	87	72	88	48	56	81	87
Spouse	43	22	12	12	10	25	38	19	11
Joint (head and spouse)	4	3	0	16	2	12	4	1	2
Other	3	0	0	0	0	15	2	0	0
Share of on-farm assets owned by:									
Head	35	59	93	73	95	7	41	78	89
Spouse	50	41	7	9	4	64	46	22	10
Joint (head and spouse)	2	0	0	18	2	3	2	. . .	1
Other	14	0	0	0	0	26	11	0	0
Share of cultivable land owned by:									
Head	29	57	92	63	94	6	35	76	87
Spouse	53	41	8	9	4	62	49	23	11
Joint (head and spouse)	4	2	0	27	2	7	5	1	2
Other	15	0	0	0	0	26	11	0	0
Share of livestock owned by:									
Head	92	9	96	78	94	93	89	98	81
Spouse	4	83	2	12	6	4	6	2	1
Joint (head and spouse)	4	8	2	10	1	3	5	0	18
Other	0	0	0	0	0	0	0	0	0
Share of cattle owned by:									
Head	100	. . .	100	100	100	100	100	100	100
Spouse	0	. . .	0	0	0	0	0	0	1
Joint (head and spouse) percent)	0	. . .	0	0	0	0	0	0	0
Other	0	. . .	0	0	0	0	0	0	0

Source: DRD/IFPRI Rural Finance Survey.

[a] Noncultivable land, buildings, furniture, and household utensils.

[b] On-farm assets (cultivable land, farm equipment, and oxen) and livestock.

credit programs, the microfinance institutions, and the commercial banks. The informal sector is made up of professional moneylenders, traders, and friends and relatives.

Table 5 shows that there were 364 formal and 212 informal loans granted during the recall period. For formal loans, the recall period was chosen to begin with membership in the credit program (for SACA, only since 1992). Larger informal loans (more than MK 100) were recalled from October 1993 until the time of the round, with the last round ending on December 20, 1995. For informal loans of less than MK 15 and ones between MK 15 and MK 100, the recall period in each of the three rounds was chosen as eight weeks and three months, respectively. A total of 121 demands for loans were rejected, 56 percent of which were rejected by informal lenders.

In total 79 percent of adults in the sample did not ask for any loan during the three rounds of the survey. The most common reason for not asking for a formal or informal loan was dislike or no need of borrowing (48 percent and 27 percent for informal and formal loans, respectively). Informal loans were mostly between friends and relatives (93 percent). The majority of them did not have any due date (57 percent). Virtually all informal loans were interest-free loans (98 percent) with an average size of MK 76. In contrast, formal loans carried an average annual interest rate of 24 percent before October 1993 and 39 percent after October 1993, and their average size was MK 377 before October 1993 and MK 520 after October 1993. These figures show that the credit market in Malawi is not as active as those in other Asian and African countries.[11]

Distribution of Credit Limits and Unused Credit Lines

Table 6 presents the average informal and formal credit limits and unused credit lines that were observed in the three rounds. This information is shown for the whole population and separately when a formal loan was granted, rejected, and not requested. The average formal and informal credit limits for the population as a whole are MK 44 and MK 46, respectively (about US$3).[12] To put these figures into perspective, Malawi's 1995 per capita GNP was US$170 or MK 2,550 (Word Bank 1997), and the average per capita 1995 income in the sample was MK 1,190. The average formal credit limit is significantly higher for cases in which formal loans were granted (MK 679 on average) compared with cases in which informal loans were granted (MK 35). One also notes that some rejected borrowers and respondents who did not ask for loans could nevertheless borrow some positive amounts from both sectors.[13]

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[11] For comparison, 2,233 informal and 338 formal loans were recorded in Bangladesh in a similar IFPRI survey in 1994 involving 350 households (Zeller, Sharma, and Ahmed 1996). In another similar IFPRI survey of 189 households in Madagascar in 1992, there were 1,375 and 245 informal and formal loans, respectively (Zeller et al. 1994).

[12] The exchange rate was US$1 for MK 15 at the time of the survey.

[13] A small number of borrowers whose loan demands were rejected could borrow a lesser but positive amount from the same lender but chose not to do so. The main reason why a rejected borrower chooses to forego a loan instead of accepting a lesser amount is that the lesser amount is usually too small for the intended purpose of the loan. In addition, when a loan demand is rejected by one sector of the credit market (formal or informal), the potential borrower can often borrow at least some amount from another sector.

Table 5—Loan transactions and their characteristics

	Male	Female	All
Sample size	1,087	1,361	2,448
Informal credit granted	113 (60%)	99 (59%)	212 (59%)
Loan size (MK)	82	67	76
Loan maturity (weeks)	13	9	11
Loans with due date (percent)	48	36	43
Loans with no due date (percent)	52	64	57
Percent annual interest rate (percent)	6	2	4
Interest-free loans (percent)	97	98	98
Relation with informal lender			
Friend or relative (percent)	95	92	93
Neighbor (percent)	2	3	3
None of the above (percent)	3	5	4
Formal credit granted	143 (40%)	221 (41%)	364 (41%)
Before October 1993			
Loan size (MK)	456	161	377
Loan maturity (weeks)	42	41	42
Loans with due date (percent)	100	100	100
Percent annual interest rate (percent)	24	23	24
Loans with positive interests (percent)	96	100	97
After October 1993			
Loan size (MK)	670	449	520
Loan maturity (weeks)	38	22	27
Loans with due date (percent)	100	100	100
Percent annual interest rate (percent)	37	40	39
Loans with positive interests (percent)	94	98	97
Loans rejected			
Informal loans	49 (55%)	27 (58%)	76 (56%)
Formal loans	31 (45%)	14 (42%)	45 (44%)
No loan requested	751 (72%)	1,000 (85%)	1,751 (79%)
Reasons for not asking for informal loans			
I did not need credit	27	23	24
I dislike any borrowing	29	20	24
Other loans are too expensive	14	16	15
I felt that lender would refuse because of:			
My age	3	8	6
My health problem	5	6	6
Reasons other than above	16	18	17
Other	5	9	7
Reasons for not asking for formal loans		(percent)	
I did not need credit	19	19	19
I dislike any borrowing	8	8	8
Other loans are too expensive	16	14	15
I felt that lender would refuse because of:			
My age	8	14	12
My health problem	7	6	6
Reasons other than above	23	24	24
Other	19	14	16

Source: DRD/IFPRI Rural Finance Survey.

Note: The percentage figures in the table are weighted using the strata population weights from the village census (the count figures are not weighted).

Table 6—Distribution of formal and informal credit limits and unused credit lines, October 1993–December 1995

	Credit limit and unused credit line[a]									
	Formal					Informal				
	Mean	Median	Standard deviation	Minimum	Maximum	Mean	Median	Standard deviation	Minimum	Maximum
All respondents	44	0	248	0	10,000	46	0	188	0	12,000
	(19)	(0)	(137)	(0)	(6,575)	(36)	(0)	(112)	(0)	(5,000)
When formal loan was granted	679	500	911	13	10,000	95	20	500	0	12,000
	(148)	(0)	(474)	(0)	(6,575)	(69)	(10)	(202)	(0)	(4,000)
When informal loan was granted	35	0	149	0	1,000	127	50	369	5	12,000
	(13)	(0)	(76)	(0)	(1,000)	(52)	(12)	(134)	(0)	(4,000)
When loan demand was rejected	72	0	254	0	4,000	46	0	89	0	400
	(53)	(11)	(215)	(0)	(4,000)	(34)	(0)	(69)	(0)	(300)
When no loan was requested	12	0	88	0	5,000	32	0	104	0	5,000
	(12)	(0)	(88)	(0)	(5,000)	(32)	(0)	(104)	(0)	(5,000)

Source: DRD/IFPRI/Rural Finance Survey.

Notes: The exchange rate is US$1 = MK 15. Malawi's 1995 per capita GNP is $170 (that is, MK 2,550; World Bank 1997).

[a] Unused credit line in parentheses.

The distributions of the credit limits and unused credit lines presented in the Table 6 and in the box plot diagrams in Figures 2–6 give a better picture of the extent of access to credit in Malawi. The median formal and informal credit limits in the population as a whole are both zero. Over 75 percent of the population can borrow at most MK 50 (about US$3) from either sector of the credit market, and most often they could obtain this amount only from the informal sector. The distributions of the unused credit lines show that more often borrowers exhaust their credit lines in the formal sector but not in the informal sector. This finding, taken together with the fact that informal loan sizes and credit limits are significantly lower than the corresponding formal values, suggests that the two types of credit are not perfect substitutes for one another. Otherwise, since almost all informal loans do not carry any interest rate, one would expect to see households reach their credit limits more frequently in the informal sector than in the formal sector. One also notes that women in general have lower formal and informal credit limits compared with men. They also appear more likely to exhaust their formal credit lines than men. This finding provides some justification for the targeting of formal credit to women.

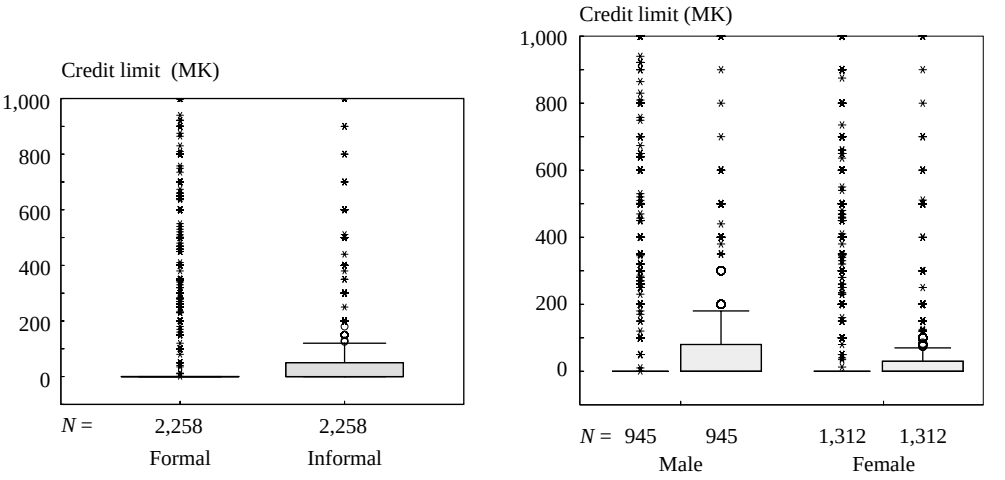
Access to Credit and Participation in Formal Credit Programs

A household is said to have access to a type of credit if at least one of its members has a strictly positive credit limit for that type of credit. Similarly a household is classified as credit constrained for a type of credit if at least one of its members is constrained for that type of credit. How do access to the two types of credit and the likelihood of having a binding credit constraint differ between participants and nonparticipants in credit programs? To answer this question, the households have been classified according to the types of access to credit and the binding of the credit constraints of their individual members.

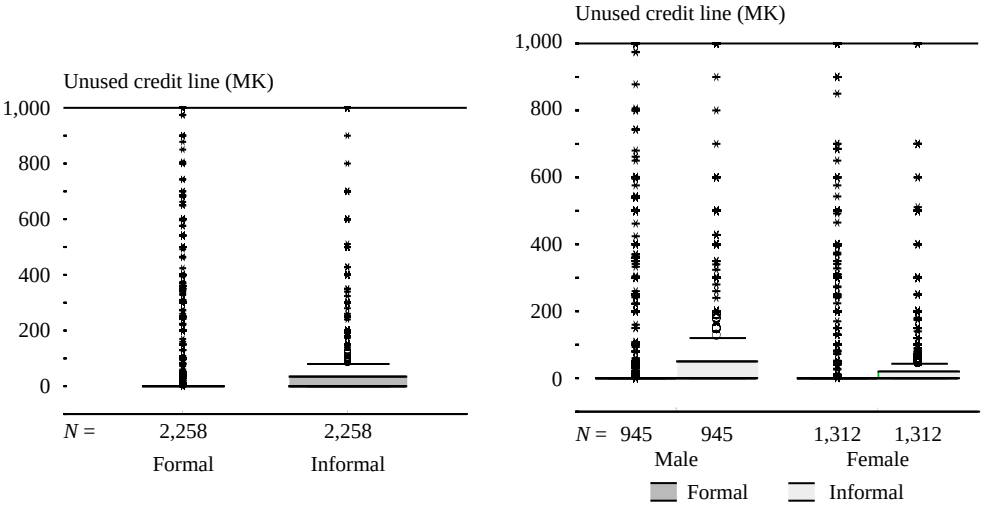
Table 7 tabulates the credit limits and occurrence of credit constraints by program membership. Consistent with our conceptual distinction between access to credit and participation in a credit program, the table shows that 8 percent of households who never participated in any credit program did have access to formal credit during the first-round recall period (that is, they said they could obtain a formal loan if they wanted to). Of households who never participated in a credit program 28 percent do not have access to any type of credit, while 64 percent have access only to informal credit. A different pattern of access to credit is shown for households who are no longer participating in credit programs. Indeed, they are four times more likely to have access to formal credit than those who never participated (32 percent compared with 8 percent). Interestingly, up to 40 percent of the households currently participating in formal credit programs did not have access to formal credit during the first-round recall period. This means that not only did they not receive any formal loan during that period, they also could not borrow anything from a formal lender. Table 7 also shows that close to half of households participated in formal credit programs during that recall period (with 15 percent having their formal and informal binding and 34 percent having only their formal binding). This indicates that these house-

Figure 2—Distributions of formal and informal credit limits and unused credit lines for all respondents, October 1993–December 1995

A. Formal and informal credit limits for all respondents



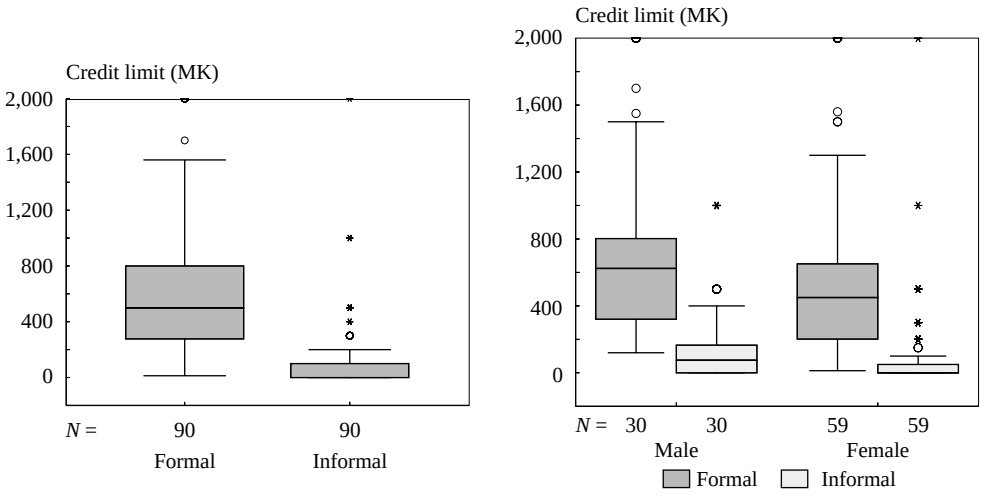
B. Formal and informal unused credit lines for all respondents



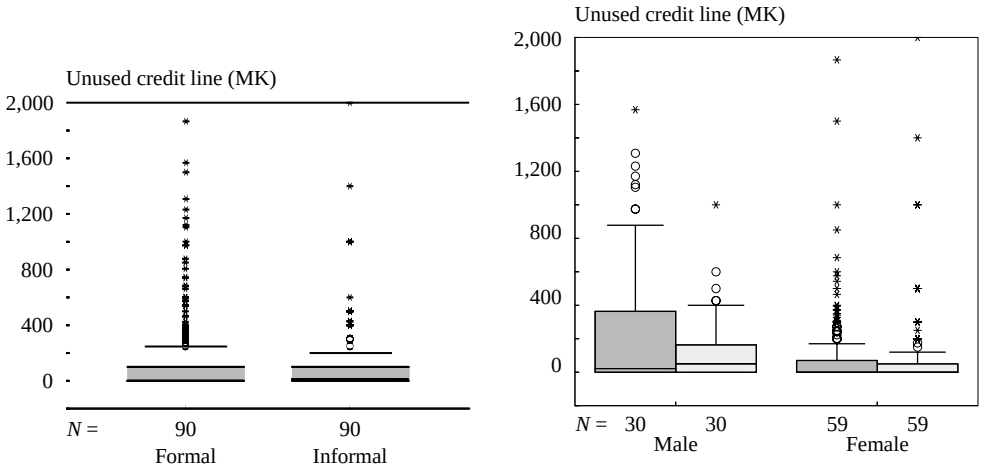
Notes: The box plot diagrams are interpreted as follows. For each box, 50 percent of cases have values within the box and the solid horizontal line inside it is the median. The length of the box is the interquartile range and the lower boundary (resp upper boundary) of the box is the 25th (resp 75th) percentile. The circles are outliers and the stars are extreme values.
The exchange rate is US$1 = MK 15. Malawi's 1995 per capita GNP was US$170 or MK 2,550 (World Bank 1997).

Figure 3—Distributions of formal and informal credit limits and unused credit lines when a formal loan was granted, October 1993–December 1995

A. Formal and informal credit limits when a formal loan was granted



B. Formal and informal unused credit lines when a formal loan was granted



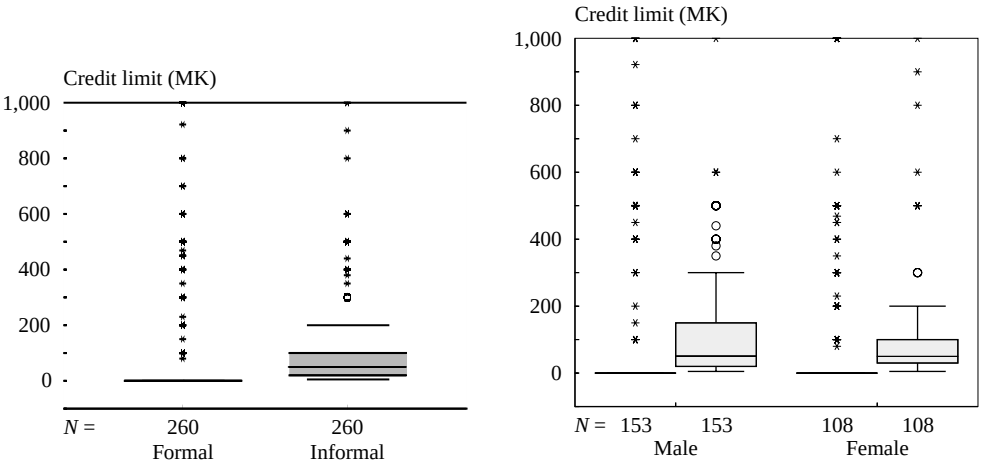
Notes: See notes to Figure 2.

holds could benefit by having their respective formal credit organizations increase their credit limits.

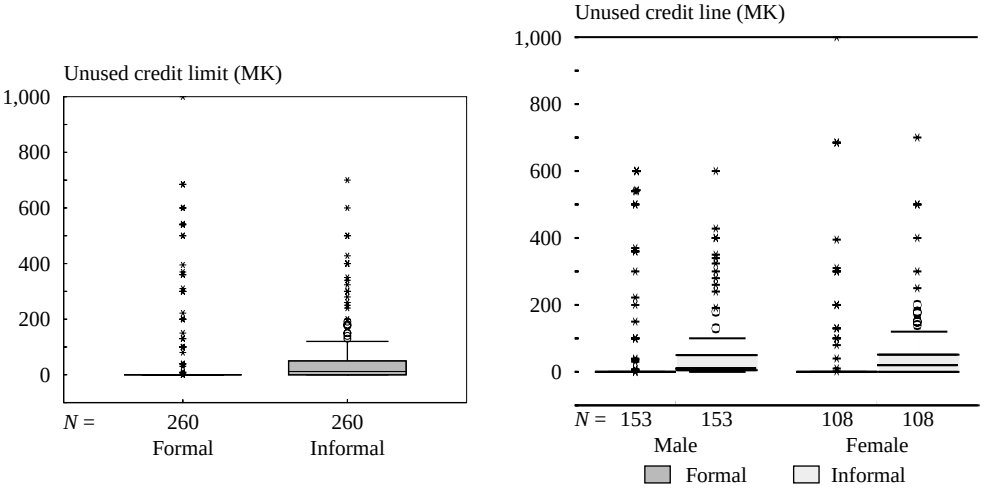
The figures for the second and third rounds in Table 7 show a progressively deteriorating trend in household access to credit for participants and nonparticipants alike. For participants, the deterioration resulted mainly from their programs' orientation or changes in their institutional settings. For example, for the MRFC credit

Figure 4—Distributions of formal and informal credit limits and unused credit lines when an informal loan was granted, October 1993–December 1995

A. Formal and informal credit limits when an informal loan was granted



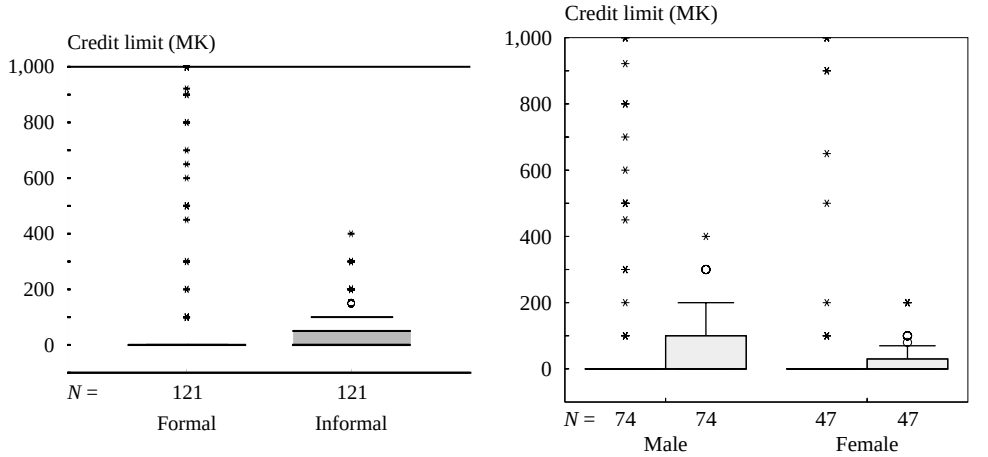
B. Formal and informal unused credit lines when an informal loan was granted



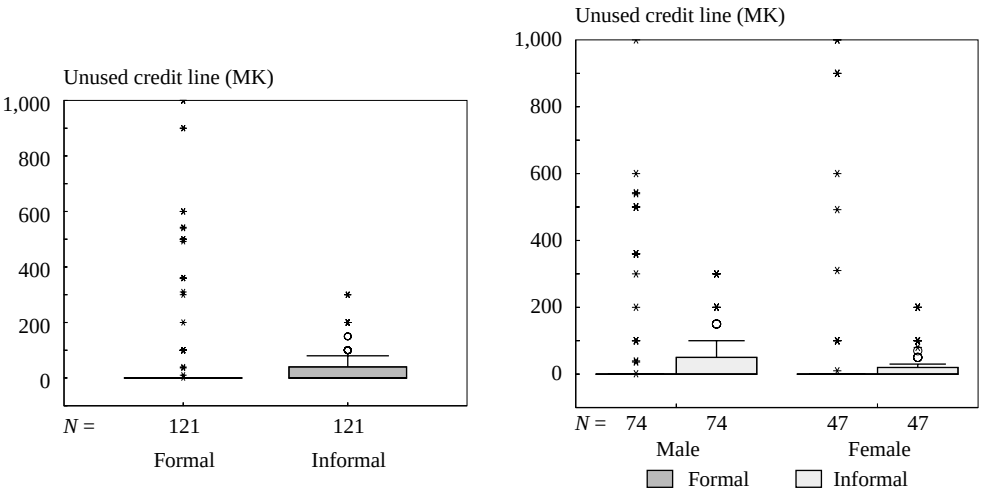
Notes: See notes to Figure 2.

Figure 5—Distributions of formal and informal credit limits and unused credit lines when a loan demand was rejected, October 1993–December 1995

A. Formal and informal credit limits when a loan demand was rejected



B. Formal and informal unused credit lines when a loan demand was rejected



Notes: See notes to Figure 2.

program, with only 23 percent and 8 percent of its member households having access to formal credit during the second and third rounds, respectively, the deteriorating trend reflects its concentration on lending for seasonal agricultural production and should have been anticipated by its members. MMF lends for nonfarm income-generating activities, and all of its members completely lost access to formal credit in the third round, which fell during the transition period when MMF was being absorbed by MRFC.

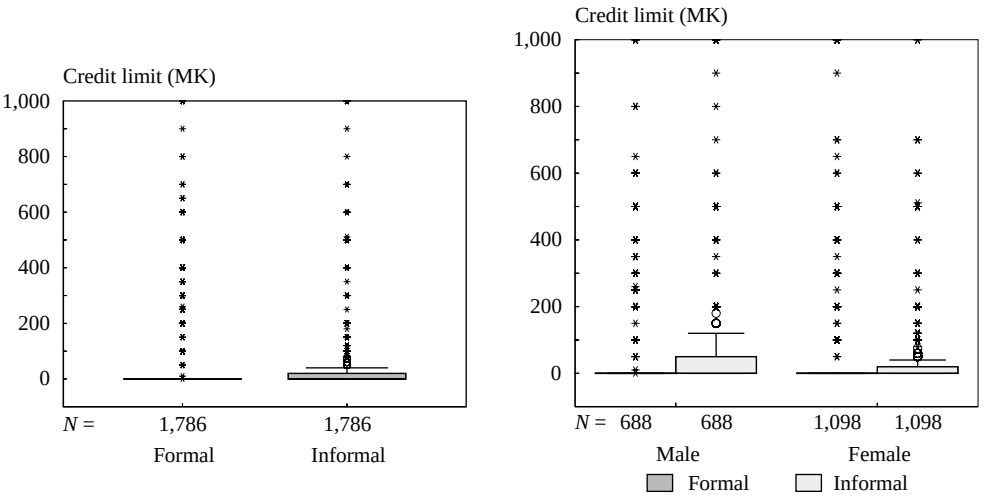
Table 7—Households with access to credit, by program membership and sector of the credit market

	Current members								
	MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All	Past members	Never been members
Round 1 (October 1993–March 1995)									
Access to credit									
No access	10 (14%)	2 (2%)	1 (2%)	2 (11%)	0 (0%)	1 (10%)	13 (10%)	12 (17%)	27 (28%)
Informal only	15 (37%)	1 (2%)	1 (0%)	6 (11%)	1 (1%)	4 (49%)	25 (30%)	33 (50%)	65 (64%)
Formal only	14 (15%)	9 (60%)	2 (6%)	11 (24%)	9 (22%)	2 (15%)	40 (16%)	1 (0%)	0 (0%)
Informal and formal	57 (34%)	18 (36%)	25 (92%)	45 (55%)	27 (76%)	10 (27%)	161 (44%)	19 (32%)	7 (8%)
Total	96 (100%)	30 (100%)	29 (100%)	64 (100%)	37 (100%)	17 (100%)	239 (100%)	65 (100%)	99 (100%)
Binding credit constraint									
Informal and formal	13 (16%)	8 (14%)	1 (2%)	7 (16%)	4 (9%)	2 (11%)	32 (15%)	14 (21%)	31 (33%)
Informal only	11 (12%)	4 (50%)	2 (6%)	7 (19%)	5 (13%)	1 (14%)	23 (12%)	1 (0%)	0 (0%)
Formal only	17 (38%)	5 (10%)	2 (2%)	19 (20%)	8 (11%)	6 (50%)	54 (34%)	32 (50%)	61 (60%)
No binding constraint	55 (34%)	13 (26%)	24 (89%)	31 (45%)	20 (66%)	8 (25%)	130 (39%)	18 (29%)	7 (8%)
Total	96 (100%)	30 (100%)	29 (100%)	64 (100%)	37 (100%)	17 (100%)	239 (100%)	65 (100%)	99 (100%)
Round 2 (April–July 1995)									
Access to credit									
No access	24 (37%)	17 (63%)	3 (0%)	10 (32%)	2 (8%)	3 (30%)	56 (34%)	15 (20%)	34 (48%)
Informal only	39 (39%)	3 (4%)	4 (12%)	22 (33%)	14 (40%)	4 (37%)	75 (35%)	41 (69%)	58 (46%)
Formal only	4 (8%)	8 (33%)	2 (5%)	11 (20%)	5 (22%)	3 (4%)	28 (10%)	1 (0%)	1 (2%)
Informal and formal	27 (15%)	0 (0%)	20 (83%)	21 (16%)	15 (29%)	7 (30%)	75 (20%)	6 (11%)	2 (3%)
Total	94 (100%)	28 (100%)	29 (100%)	64 (100%)	36 (100%)	17 (100%)	234 (100%)	63 (100%)	95 (100%)

Binding credit constraint														
Informal and formal	27	(46%)	24	(94%)	5	(7%)	17	(39%)	4	(18%)	6	(46%)	76	(44%)	16	(20%)	41	(53%)
Informal only	2	(3%)	2	(4%)	1	(2%)	4	(13%)	3	(13%)	1	(1%)	11	(3%)	0	(0%)	1	(2%)
Formal only	38	(36%)	2	(2%)	3	(8%)	24	(34%)	15	(41%)	4	(23%)	75	(33%)	41	(69%)	51	(41%)
No binding constraint	27	(15%)	0	(0%)	20	(83%)	19	(15%)	14	(28%)	6	(30%)	72	(20%)	6	(11%)	2	(3%)
Total	94	(100%)	28	(100%)	29	(100%)	64	(100%)	36	(100%)	17	(100%)	234	(100%)	63	(100%)	95	(100%)
Round 3 (July–December 1995)														
Access to credit														
No access	43	(74%)	14	(73%)	11	(35%)	27	(53%)	15	(55%)	9	(57%)	103	(65%)	33	(58%)	58	(71%)
Informal only	16	(18%)	13	(27%)	4	(16%)	10	(10%)	6	(17%)	1	(24%)	49	(20%)	25	(38%)	31	(27%)
Formal only	21	(6%)	1	(0%)	2	(11%)	14	(27%)	4	(12%)	3	(18%)	39	(9%)	1	(0%)	3	(2%)
Informal and formal	14	(2%)	0	(0%)	10	(39%)	11	(10%)	9	(16%)	2	(1%)	37	(6%)	3	(4%)	1	(0%)
Total	94	(100%)	28	(100%)	27	(100%)	62	(100%)	34	(100%)	15	(100%)	228	(100%)	62	(100%)	93	(100%)
Binding credit constraint														
Informal and formal	48	(75%)	14	(73%)	11	(35%)	34	(61%)	17	(61%)	10	(58%)	117	(68%)	33	(58%)	61	(73%)
Informal only	17	(5%)	1	(0%)	2	(11%)	8	(19%)	2	(6%)	2	(17%)	27	(7%)	1	(0%)	3	(2%)
Formal only	15	(18%)	13	(27%)	4	(16%)	10	(10%)	8	(20%)	1	(24%)	50	(19%)	25	(38%)	28	(25%)
No binding constraint	14	(2%)	0	(0%)	10	(39%)	10	(10%)	7	(13%)	2	(1%)	34	(6%)	3	(4%)	1	(0%)
Total	94	(100%)	28	(100%)	27	(100%)	62	(100%)	34	(100%)	15	(100%)	228	(100%)	62	(100%)	93	(100%)

Source: DRD/IFPRI Rural Finance Survey.

Figure 6—Distribution of formal and informal credit limits when no loan was requested, October 1993–December 1995



Notes: See notes to Figure 2.

The deteriorating trend in households' access to credit illustrates the fact that, even for participants in credit programs, continuous access to formal credit cannot be taken for granted and should be considered (together with access to informal credit) as subject to random events. Moreover, from the participating household's perspective, unforeseen fluctuations in its access to formal credit introduce a type of uncertainty into its planning and decisionmaking process that can be more difficult to cope with than the uncertainty faced when not participating in a credit program in the first place. Indeed, unpredictable institutional changes or abrupt changes in the policy of a credit program can wreak considerable damage on the operations of a business or farm enterprise.

Household Crop Production and Incomes

Crop Production in the 1993/94 and 1994/95 Seasons. During the rainy seasons 1993/94 and 1994/95, 7 percent and 3 percent of rural households, respectively, did not grow any crops at all, with male-headed households accounting for a slightly higher share of nonagricultural households. Over 90 percent of households grew food crops in both years, but only 7 percent in 1994 (11 percent in 1995) of them grew export crops, such as tea, tobacco, sugar, or cotton. Female-headed households, as expected, are underrepresented among those households growing export crops (Table 8). In 1995 51 percent of households grew local maize varieties, but 61 percent grew hybrid maize. However, among female-headed households relatively more local maize is grown compared with male-headed households. After maize, beans are the

Table 8—Major rainfed crops grown, by household

	1994			1995		
	Male	Female	All	Male	Female	All
Sample size	293	109	402	288	101	389
Number of crops	16 (9%)	4 (4%)	20 (7%)	13 (3%)	4 (2%)	17 (3%)
Food crops	277 (91%)	105 (96%)	382 (93%)	277 (97%)	96 (98%)	373 (97%)
Local maize	170 (56%)	63 (53%)	233 (55%)	148 (49%)	55 (56%)	203 (51%)
Hybrid maize	190 (63%)	64 (57%)	254 (61%)	210 (66%)	60 (51%)	270 (61%)
Other food crops	102 (35%)	33 (34%)	135 (35%)	96 (32%)	30 (36%)	126 (34%)
Cassava	20 (8%)	9 (9%)	29 (8%)	18 (7%)	7 (7%)	25 (7%)
Beans	39 (15%)	15 (17%)	54 (15%)	38 (16%)	16 (24%)	54 (18%)
Groundnut	45 (11%)	12 (12%)	57 (12%)	39 (11%)	8 (8%)	47 (10%)
Other food crops	21 (8%)	2 (0%)	23 (5%)	16 (3%)	3 (2%)	19 (3%)
Export crops	49 (9%)	5 (2%)	54 (7%)	80 (14%)	11 (2%)	91 (11%)
Tobacco	37 (5%)	5 (2%)	42 (4%)	70 (11%)	9 (1%)	79 (8%)
Other export crops	12 (5%)	0 (0%)	12 (3%)	14 (5%)	2 (1%)	16 (4%)

Source: DRD/IFPRI Rural Finance Survey.

second most important crop, followed by groundnut and cassava. All other food crops, except maize, are grown in only some 35 percent of rural households, indicating the high specialization in maize and implying little diversity in diet if households are not able to purchase other staple foods and relishes. Beans are grown relatively more frequently in female-headed households than in male-headed households. Tobacco is of increasing importance as a cash crop; it is grown mainly in male-headed households. While 2 percent of female-headed households grew tobacco in 1994, only 1 percent grew it in 1995. In comparison, the percentage of male-headed tobacco-growing households increased from 5 percent in 1994 to 11 percent in 1995. Overall, the number of tobacco-growing smallholders doubled from one year to the next.

Table 9 shows the amount of cultivated land and share of land allocated to each crop in the 1994/95 season, differentiated by program membership. On average, each household in the survey area cultivated 0.7 hectare. Of cultivated land, 46 percent was allocated to hybrid maize and 38 percent to local maize. Therefore 84 percent of household cultivated land was devoted to growing maize, the main food staple. In contrast, only 2 percent of the cultivated land was devoted to tobacco in 1994/95. The remaining 14 percent of household cultivated land was devoted to the growing of other crops (mostly cassava, beans, and groundnut). Differentiating by program membership, members of the two PMERW programs had the lowest average amount of cultivated land (0.6 and 0.7 hectare, respectively, compared with 0.9 for MRFC members and 0.8 for MMF and MUSCCO members). Nonmembers and past members also cultivated only 0.7 hectare. Of further note is that PMERW1 and MMF households had a relatively high share of their cultivated land planted with hybrid maize while PMERW2 households had a significantly higher share of land allocated

Table 9—Household cultivated land and its allocation among crops in the 1994/95 season, by credit program membership

	All households	Current members							Past members	Never been members
		MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All		
Average area of land cultivated (hectares)	0.7	0.9	0.8	0.8	0.6	0.7	10.4	0.9	0.7	0.7
Proportion of land planted to:										
Local maize (percent)	38	43	9	13	12	21	37	35	51	36
Hybrid maize (percent)	46	49	91	65	71	47	54	53	30	46
Tobacco (percent)	2	3	0	13	5	25	2	4	3	1
Other crops (percent)	14	5	0	9	12	7	7	8	16	16

Source: DRD/IFPRI Rural Finance Survey.

to tobacco (25 percent compared with an average of 4 percent for all program members). The most important result from this table is that nonmembers or past members cultivated only 30–46 percent of their land with hybrid maize, while, on average, all program members cultivated 53 percent.

Acquisition and Financing of Agricultural Inputs. Table 10 reports the prevalence of fertilizer and pesticide use in the 1994/95 season, differentiated by crop and by program membership. Only 11 percent of program households did not apply chemical fertilizer. In comparison, 53 percent of past members and 40 percent of households that never belonged to a credit program did not use chemical fertilizers. This result strongly suggests that participation in credit programs has a positive effect on the adoption of fertilizer. For pesticides, this pattern is similar but less clearly accentuated. There were, however, differences in the prevalence of fertilizer use among members of the different credit programs. While only 5 percent of MRFC households did not use any chemical fertilizer, 29 percent of MMF and up to 16 percent of PMERW members did not use chemical fertilizer. These latter two programs target loans to off-farm enterprises, while MRFC gave in-kind input loans mostly for hybrid maize and tobacco. Table 10 and especially Table 11 reveal an interesting pattern regarding the allocation of chemical fertilizer among the different crops: chemical fertilizer, when applied, is most frequently used for hybrid maize, followed by local maize, and then tobacco. Very few other crops receive chemical fertilizer. It is noteworthy that MRFC members exhibit the same pattern of fertilizer use despite the fact that they are supposedly receiving more in-kind loans for tobacco than for hybrid maize (see Table 1). For example, 50 percent of the chemical fertilizer acquired in 1994/95 by MRFC members was used on hybrid maize, compared with 11 percent used on tobacco and 39 percent used on local maize (Table 11). The same pattern applies for the 1993/94, 1994/95, and 1995/96 seasons. As shown in Table 11, even smallholder tobacco farmers applied chemical fertilizer on tobacco and hybrid maize in about equal amounts. This indicates that MRFC members are diverting a large portion of their tobacco loan packages toward their food crops.

Table 10 also indicates the relative importance of the different methods of acquisition and sources of financing of inputs. Inputs are mostly financed through smallholders' own resources. For both credit program members and nonmembers, over two-thirds of total input value was financed without credit or gifts. Among the credit programs, MRFC provides the largest flow of financing. In 1994/95 16 percent of inputs were financed through MRFC credit. The other programs are limited in scale and therefore achieve small shares when these are calculated as an average over the survey areas. The informal market provides very little input financing.

The government's programs to distribute free fertilizer and seeds under the Drought Relief Program became an increasingly important source of input financing between 1994 and 1995. The input distribution programs sought to target vulnerable households that were adversely affected by the 1993/94 drought. However, the programs continued until mid-1996, as the harvest in 1994/95 was also below average. In the 1994/95 season, households who never participated in a credit program received 22 percent of their inputs as gift. But as the government programs attempt to

Table 10—Fertilizer acquisition and relative importance of different methods of acquisition and source of financing of inputs in the 1994/95 season, by program membership

	Current members							Past members	Never been members
	MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All		
	(percent)								
Proportion of households using:									
Chemical fertilizer in:									
No crop	5	29	9	10	16	26	11	53	40
Local maize	54	11	2	11	22	42	40	19	12
Hybrid maize	72	67	91	82	76	74	71	35	45
Tobacco	14	0	32	9	36	2	13	12	5
Other crops	0	0	0	1	0	0	0	3	0
Pesticide in:									
No crop	92	100	86	86	84	99	92	96	100
Local maize	0	0	0	0	0	0	0	0	0
Hybrid maize	1	0	2	0	6	0	1	0	0
Tobacco	7	0	11	4	9	1	6	1	0
Other crops	0	0	0	10	2	0	2	4	0

Percent of the total inputs that was:									
Purchased with own income	59	71	29	61	62	51	55	54	54
Part of a credit package	19	0	56	1	14	21	20	2	0
Single-item, in-kind credit	4	0	0	2	3	0	3	5	1
Purchased with cash credit	0	0	11	0	0	0	2	2	1
Received as a gift	2	12	0	12	3	0	4	7	26
Home-produced	15	17	3	24	18	28	16	30	19
Given by landlord	0	0	0	0	0	0	0	0	0
In-kind payment for work	0	0	0	0	0	0	0	0	0
Percent of the total inputs from:									
Self-financing	81	88	33	87	82	99	76	88	74
MRFC/SACA	16	0	7	2	13	1	11	1	0
MUSCCO	1	0	60	0	0	0	9	0	0
Other government program	2	12	0	9	5	0	4	8	22
Other NGO program	0	0	0	1	0	0	0	1	1
Relative/friend/neighbor	0	0	0	0	0	0	0	1	3
Landlord/informal lender	0	0	0	0	0	0	0	0	0

Source: DRD/IFPRI Rural Finance Survey.

Table 11—Distribution of fertilizer among crops in the 1993/94, 1994/95, and 1995/96 seasons, by program membership and type of farm

	Type of farm			Current program members							Past members	Never been members
	All	Tobacco	Nontobacco	MRFC	Mudzi Fund	MUSCCO	PMERW1	PMERW2	Other	All		
	(Percent of MK value of total chemical fertilizer used)											
1993/94 season												
Local maize	30	1	34	31	3	1	9	4	. . .	27	25	42
Hybrid maize	64	52	66	66	97	75	83	65	91	70	65	55
Tobacco	5	47	. . .	2	0	24	8	32	9	4	9	4
Other crops	0	. . .	1	. . .	. . .	. . .	. . .	. . .	. . .	. . .	2	. . .
1994/95 season												
Local maize	26	15	29	39	11	2	8	12	41	31	31	21
Hybrid maize	65	41	71	50	89	79	76	49	53	57	54	75
Tobacco	8	42	. . .	11	0	20	15	39	6	12	12	4
Other crops	0	1	0	0	. . .	. . .	0	. . .	. . .	0	2	. . .
1995/96 season												
Local maize	28	4	30	30	. . .	3	. . .	2	58	26	31	29
Hybrid maize	67	46	69	63	90	33	81	47	25	66	68	67
Tobacco	5	50	. . .	7	. . .	64	19	52	18	8	1	3
Other crops	1	. . .	1	. . .	10	. . .	. . .	. . .	. . .	0	. . .	2

Source: DRD/IFPRI Rural Finance Survey.

target the poorer rural households, it is interesting to note that 9 percent of inputs in PMREW1 households, 5 percent of inputs in PMERW2 households, and 12 percent of inputs in MMF households are provided as gifts through government programs. Only 2 percent of inputs in MRFC households that have above-average wealth were given by the government. On average for all program households, 4 percent of inputs were obtained through government programs. The corresponding percentage for past members was 8 percent. The increasing importance of the free distribution of inputs is, of course, detrimental to the formation of private input and credit markets, especially to the extent that wealthier households—who otherwise would have bought inputs on a cash basis or on credit—are reached through the input distribution programs.[14]

Yield and Net Agricultural Income by Crop. Tables 12 and 13 present yields, input expenditures per hectare, and financial indicators for different crop enterprises during the 1994 and 1995 production years, respectively. The figures are shown for all households and by program membership. Table 13 shows that tobacco had the highest return in terms of net income per hectare with MK 3,104 in 1994 and MK 5,896 in 1995, followed by other crops (beans, cassava, and so forth) with MK 1,271 in 1994 and MK 2,030 in 1995, then local maize with MK 398 in 1994 and MK 851 in 1995, and last hybrid maize with MK 313 in 1994 and MK 615 in 1995. Owing to high prices for seed and especially fertilizer, and to high interest rates, hybrid maize has lost much of its relative profitability compared with local maize since the predrought and pre–market reform years. Tobacco is by far the most competitive smallholder crop. One also notes that the average net returns per hectare for all crops in 1994, the drought year, are about half of those in 1995, demonstrating that the profitabilities of all the crops cultivated by smallholder farmers in Malawi are equally and highly vulnerable to drought.

Several general patterns can be identified when the results are differentiated by program membership. First, current program members have lower hybrid maize yields than past members, but higher yields compared with households that have never been members. Second, given their higher input intensity but their lower hybrid maize yields, current program members have much lower per-hectare gross margins for local and hybrid maize crops in both years than households who were past members of credit programs. Consequently their aggregate gross margin per hectare for all crops combined was much lower in 1994 (MK 426) than that of past members (MK 705) and that of households that have never participated (MK 715). Furthermore, despite spending, on average, twice as much on input per hectare in 1995 than past members, their aggregate gross margins per hectare were only 22 percent higher (MK 1,791 compared with MK 1,469). Those households that have never been members had much lower gross margins per hectare in 1995 (MK 1,157).

These results raise concerns about the sustainability and household-level impact of the agricultural credit services of MRFC, MUSCCO, and MMF. Although the first

[14] At the national level, free distribution of inputs constituted 14 percent and 50 percent of fertilizer and hybrid maize use, respectively (APAP III Newsbriefs 1996).

Table 12—Average yield and net income per hectare for major rainfed crops, 1994 production year, by program membership

	All households	Current members							Past members	Never been members
		MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All		
Yield (kilograms per hectare)										
Local maize	586	663	519	469	587	905	358	620	724	529
Hybrid maize	828	520	143	1,373	418	930	973	697	1,229	782
Tobacco	861	998	. . .	782	809	1,188	1,423	863	684	1,117
Other crops	1,464	657	74	831	1,058	515	2,482	873	773	1,880
All crops	922	591	222	997	548	896	1,034	712	874	996
Chemical fertilizer (MK per hectare) used in:										
Local maize	247	251	130	106	169	201	. . .	226	345	210
Hybrid maize	320	231	182	366	238	284	360	265	453	302
Tobacco	445	520	. . .	427	522	712	559	418	483	417
Other crops	1,334	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1,334
All crops	315	163	110	171	156	248	247	160	166	57
Total value of inputs per hectare (MK per hectare)[a]										
Local maize	114	227	119	52	162	165	185	189	133	91
Hybrid maize	287	354	258	395	362	533	661	381	450	212
Tobacco	566	811	. . .	819	700	1,313	1,656	644	564	501
Other crops	139	173	15	162	153	599	458	203	113	139
All crops	199	306	224	313	308	567	565	312	232	156
Gross margin per hectare (MK per hectare)										
Local maize	398	288	227	333	158	491	125	281	634	339
Hybrid maize	313	119	–111	419	–102	78	378	155	321	371
Tobacco	3,104	2,713	. . .	2,910	2,869	6,796	11,423	2,664	1,411	5,926
Other crops	1,271	1,082	106	1,079	688	130	1,423	1,028	967	1,451
All crops	664	382	–35	787	139	1,021	844	426	705	715

Source: DRD/IFPRI Rural Finance Survey.

[a] US$1 = MK 15.

Table 13—Average yield and net income per hectare for major rainfed crops, 1995 production year, by program membership

	All households	Current members							Past members	Never been members
		MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All		
Yield (kilograms per hectare)										
Local maize	725	913	425	789	989	1,132	792	868	806	674
Hybrid maize	793	663	496	1,371	537	1,068	821	769	1,179	731
Tobacco	706	782	. . .	1,839	1,018	1,492	1,185	1,067	524	447
Other crops	1,232	561	. . .	1,336	1,537	1,135	1,935	1,155	603	1,446
All crops	884	724	489	1,378	791	1,171	967	879	818	904
Chemical fertilizer (MK per hectare) used in:										
Local maize	246	253	180	292	239	376	165	246	183	269
Hybrid maize	247	265	192	510	220	451	274	296	296	218
Tobacco	496	832	. . .	722	662	922	595	779	459	254
Other crops	510	509	. . .	. . .	287	. . .	. . .	427	524	. . .
All crops	275	268	154	429	182	416	213	267	130	102
Total value of inputs per hectare (MK per hectare)[a]										
Local maize	203	307	840	130	956	679	375	387	147	194
Hybrid maize	317	333	305	568	309	572	418	372	359	288
Tobacco	847	1,036	. . .	2,763	988	1,226	840	1,527	592	313
Other crops	179	329	. . .	152	372	483	280	301	141	175
All crops	273	416	355	823	413	707	405	497	224	229
Gross margin per hectare (MK per hectare)										
Local maize	851	1,034	–260	977	373	1,014	922	871	1,109	757
Hybrid maize	615	377	83	1,102	258	749	612	495	1,025	585
Tobacco	5,896	9,826	. . .	9,105	10,211	23,932	21,747	8,669	3,838	4,278
Other crops	2,030	1,855	. . .	2,108	3,488	1,584	2,511	2,429	1,810	2,045
All crops	1,322	1,870	51	2,801	1,376	5,382	1,629	1,791	1,469	1,157

Source: DRD/IFPRI Rural Finance Survey.

[a] US$1 = MK 15.

two institutions only lent for agriculture in 1995, MMF also provided off-farm loans. However, whenever these programs lend for agriculture, they provide a prespecified seed and fertilizer package, for either hybrid maize or tobacco. The amounts of seed and fertilizer contained in the packages are standardized for a limited number of landholding sizes. Three potential hypotheses could explain the apparent negative effect of credit program membership on gross margins:

1. Are current program members endowed with land of lower quality than noncurrent members?
2. Or did the programs select for the disadvantaged, less skilled farmers, while the past members are the better farmers, who chose to stay out of the agricultural credit system after defaulting on previous loans to SACA?
3. Or, as already suggested by Msukwa et al. (1994), are the extension advice and credit packages—especially those of MRFC, MMF, and MUSCCO—suboptimal, encouraging the application of too much of fertilizer and seed with a view to enhancing yield instead of profitability? In 1995, as in prior years, the package for hybrid maize was not adapted to specific agroecological conditions but instead followed the general recommendation of the Ministry of Agriculture for the nation as a whole, which was to apply 96 kilograms of nitrogen and 40 kilograms of phosphate per hectare (Government of Malawi 1994b). Table 14 shows the recommended levels of application for different fertilizer compounds and the estimated average cost per hectare. The costs of the recommended applications during the 1993/94 season were MK 278 for local maize and MK 645 for hybrid maize. The costs for both crops more than tripled during the 1994/95 season, following the devaluation of the kwacha and the elimination of fertilizer subsidies.

The patterns in Table 13 and Figures 7–10 give more credibility to the third hypothesis. In 1995 current members achieved gross margins per hectare of local and hybrid maize of MK 871 and MK 495, respectively. They applied, on average, MK 246 and MK 296 of fertilizer per hectare, respectively, to the two crops. Past members who applied the same level of fertilizer to hybrid maize but much less fertilizer to local maize (MK 183 per hectare) earned 100 and 27 percent more per hectare, respectively. Households that have never been members earned gross margins of MK 757 and MK 585 per hectare on local maize and hybrid maize by applying, respectively, MK 269 and MK 218 of fertilizer per hectare to the two crops. Although one may conclude that current members are inefficient hybrid maize farmers or have land of lower quality, they are much better tobacco farmers than past members or than households that have never been members. Indeed, current members achieve much higher yields and gross margins (MK 8,669) per hectare of tobacco than past members (MK 3,838) and households that have never been members (MK 4,278). Therefore, given the fact that the quality of land is unlikely to have any significant *differential* impact on maize and tobacco and that the latter is a much more complex crop to grow, the hypothesis of lower land quality and more disadvantaged, less skilled farmers among current members seems to have little justification.

Table 14—Fertilizer recommendations for maize and tobacco in Malawi

Combination of fertilizer compounds	Local maize		Hybrid maize		Burley tobacco	
	Basal dressing fertilizer	Top dressing fertilizer	Basal dressing fertilizer	Top dressing fertilizer	Basal dressing fertilizer	Top dressing fertilizer
	(kilograms/hectare)					
Combination 1	22 kilograms DAP	78 kilograms urea	87 kilograms DAP	175 kilograms urea	450 kilograms Super C (8:24:20)	150–400 kilograms
Combination 2	22 kilograms DAP	133 kilograms CAN	87 kilograms DAP	290 kilograms CAN	450 kilograms Super D (10.:24:20)	150–400 kilograms
Combination 3	22 kilograms DAP	170 kilograms S/A	87 kilograms DAP	390 kilograms S/A	600 kilograms Ordinary C (6:18:15)	150–400 kilograms
Combination 4	50 kilograms 23:21: 0+4S	65 kilograms urea	200 kilograms 23:21: 0+4S	107 kilograms urea	600 kilograms Ordinary D (8:18:15)	150–400 kilograms
Combination 5	50 kilograms 23:21: 0+4S	110 kilograms CAN	200 kilograms 23:21: 0+4S	185 kilograms CAN		
Combination 6	50 kilograms 23:21: 0+4S	150 kilograms S/A	200 kilograms 23:21: 0+4S	238 kilograms S/A		

Average estimated cost per hectare of recommended fertilizer			
Local maize		Hybrid maize	
1994 season	1995 season	1994 season	1995 season
(Mk/hectare)			
278	1,024	645	2,160

Source: Government of Malawi (1996).

Notes: Recommended combinations of fertilizer compounds are based on the recommended rate of 96 kilograms of nitrogen and 40 kilograms of phosphorus per hectare.

Fertilizer compounds come in 50-kilgram bags. Fertilizer costs are estimated using ADMARC prices and prices in Benson (1997) for the compounds DAP, CAN, urea, and 23:21:0+45.

S/A = sulfate of ammonia.

Indeed, the hypothesis that credit program members have applied fertilizer beyond optimal levels is confirmed by the plots of local maize, hybrid maize, and tobacco yields and gross margins against fertilizer use and total input cost, which are shown in Figures 7–10. All three crops show diminishing marginal returns on fertilizer use at all levels of application, with their yields (except those for hybrid maize) peaking within the observed ranges of fertilizer application. Furthermore, the gross margins per hectare for hybrid and local maize varieties are decreasing functions of fertilizer use within the entire range of observed fertilizer application. The gross margin per hectare for tobacco shows a positive but diminishing marginal return on fertilizer use. The same trends for yields and gross margins are exhibited when the total cost per hectare of all inputs is used in place of fertilizer cost per hectare, except that tobacco yield peaks within the observed range of total input use while its gross margin peaks outside the range.

Hence the yield and gross margin plots demonstrate that, at least for maize crops, the recommended fertilizer package encourages the use of too much fertilizer at the expense of the profitability of the crop enterprise.

Figure 7—Yields of local maize, hybrid maize, and tobacco versus fertilizer use

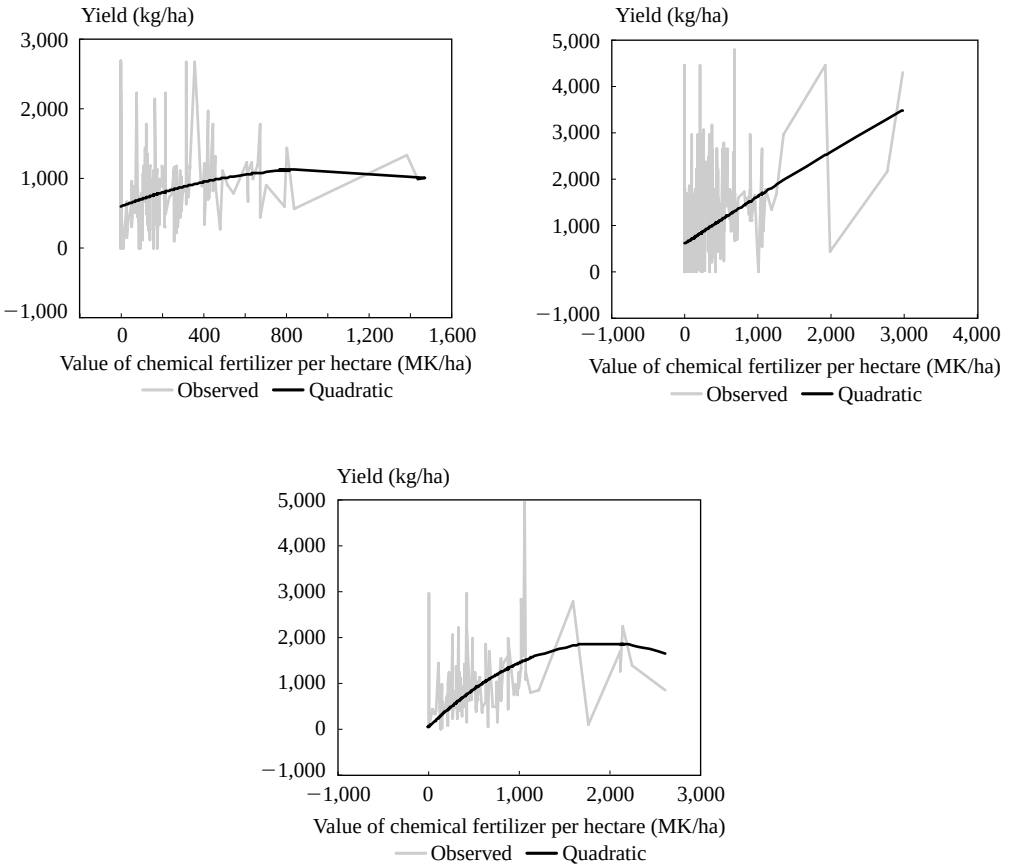
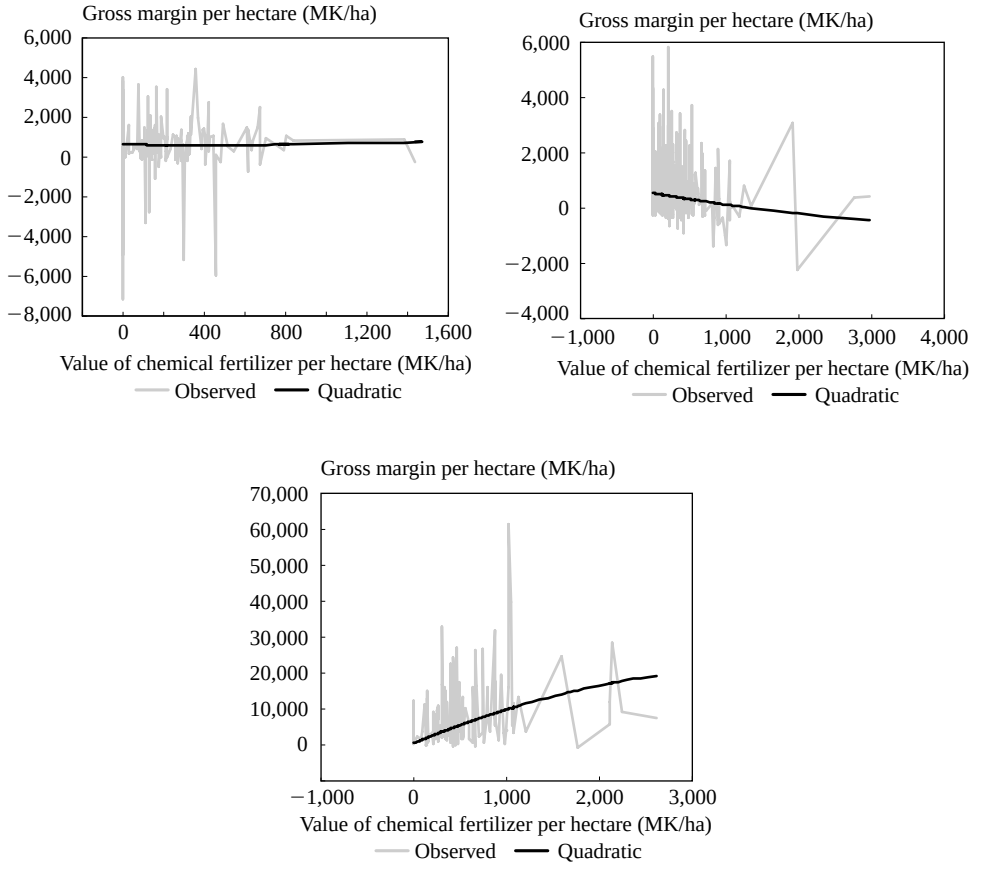
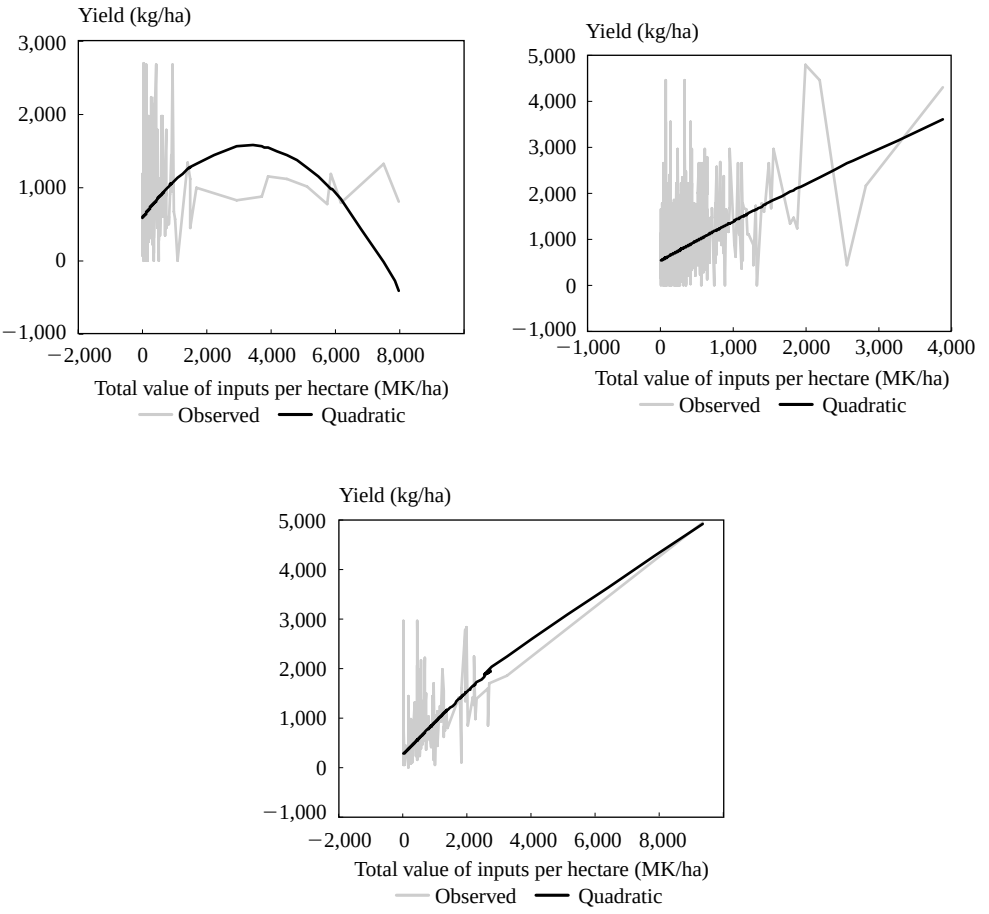


Figure 8—Gross margins of local maize, hybrid maize, and tobacco versus fertilizer use



Despite having a much steeper positive yield slope than local maize, hybrid maize shows a much steeper negative gross margin slope. This indicates that the unprofitability of hybrid maize in most parts of the observed range of fertilizer application results from the high price ratio of fertilizer to maize. Benson (1997) arrives at the same conclusion using data from farm trials at 1,600 sites across Malawi. A close examination of the data reveals that the very high rates of fertilizer application shown in Figures 7–10 occur on plots with a total size of less than 0.25 hectare. This suggests that many smallholder farmers are attempting to make up for their scare land, limiting the total output they can achieve, by applying as much fertilizer they can get hold of. This is especially true for tobacco, which was allocated only 2 percent of the average 0.7 hectare of land cultivated by smallholder farmers. Smallholder farmers are devoting so little land to tobacco, which has a much higher gross margin per hectare than maize, mainly because of their desire to be food self sufficient. Indeed, in a study by Smale and Phiri (1998) 90 percent of smallholder farmers declared the

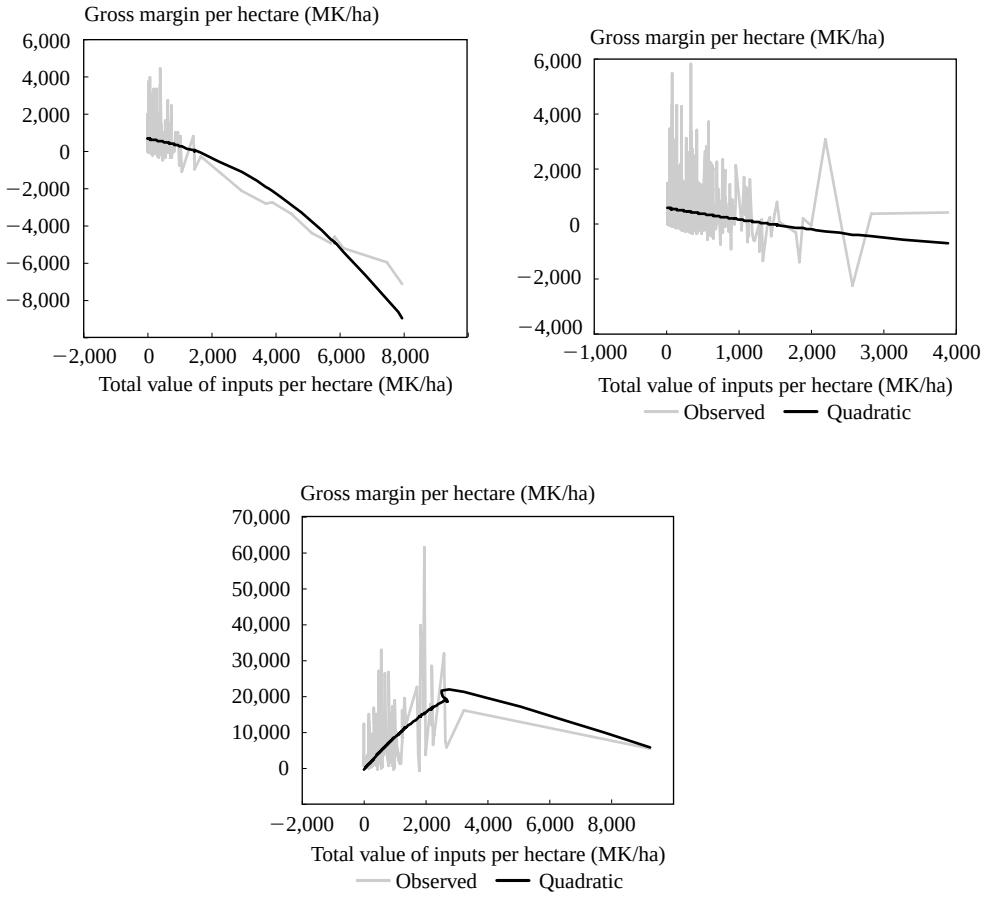
Figure 9—Yields of local maize, hybrid maize, and tobacco versus total input cost



ability to produce maize for consumption from harvest to harvest as their most important criterion of well-being.[15] Smallholder farmers may also be trying to offset yield declines in recycled hybrid maize seed by applying more fertilizer than necessary (Smale and Phiri 1998). The combination of the fact that the fertilizer packages are standardized for a limited number of landholding sizes with the fact that the fertilizers come in 50-kilogram bags is also likely to have contributed to the problem of excessive application. By encouraging the use of too much fertilizer on very tiny plots, the scarcity of land is having an indirect negative effect on the profitability of crop enterprises.

[15] Achieving food self-sufficiency at both the household and national levels is the objective set by the Ministry of Agriculture in the *Guide to Agricultural Production in Malawi* (Government of Malawi 1996).

Figure 10–Gross margins of local maize, hybrid maize, and tobacco versus total input cost



The hypothesis that the amount of fertilizer recommended by the agricultural extension service for hybrid maize was excessive before, and more so after, the removal of the fertilizer subsidy is supported by a number of studies during the 1990s. Byerlee (1992) observed that, whereas the official recommended fertilizer application level would produce the highest yields, lower levels of fertilizer use are generally more profitable for the farmer (cited in Simler 1994). A study by the Harvard Institute for International Development (HIID) in 1994 on fertilizer policy referred to the findings of the national maize research program supported by the Centro Internacional de Mejoramiento de Maíz y Trigo. In view of the constraints on resource-poor, partially subsistence oriented farmers, in recent years this program released new hybrid semiflint varieties with superior pounding and on-farm storage characteristics and shorter maturities, along with recommendations for lower fertilizer input.[16] The

[16] On hybrid maize varieties and their adoption in Malawi see Smale, Heisey, and Leathers (1995).

main conclusion reached by HIID was that the current single nationwide recommendation for fertilizer application for maize meant that in many regions farmers were asked to apply too much fertilizer (especially phosphate), and that region- and soil-specific recommendations are urgently required (Harvard Institute for International Development 1994a). Consistent with this finding, the high cost of seed and fertilizer was the major reason cited for not growing hybrid maize in a study undertaken in the Zomba District in 1995/96. Cost as a barrier to use was seen not only for fertilizer but also to a lesser extent for hybrid maize seed (Peters 1996; Smale and Phiri 1998). In the study by Smale and Phiri 71 percent of smallholder farmers did not plant first-generation (nonrecycled) hybrid maize seed because of cash constraints. In the sample investigated by Peters in the Zomba District 57 percent of farmers used recycled hybrid maize seeds, which, according to the survey households, were preferable because of their shorter maturity compared with local maize varieties (Peters 1996). Similar recent declines in fertilizer use, in response to the abolition of fertilizer subsidies and the devaluation of the kwacha, which substantially increased fertilizer prices, were found by Mangani and Chaweza (1998). Another study suggested that "more efficient production can be achieved with a lower fertilizer application, an increase in the nitrogen-phosphate ratio, and use of fertilizer compounds that can be applied by resource-poor farmers in a single application at planting" (HIID 1994b:6).

The findings of a comprehensive study of fertilizer use in Malawi are in line with these recommendations. It draws on data from on-farm trials of fertilizer use in maize from more than 1,600 sites. Gross margin calculations by Benson (1997) based on this data have shown that fertilizer use in maize production is barely profitable owing to the very low price of maize compared with the very high price of fertilizer (Benson 1997). As pointed out earlier, during both survey years the maize-fertilizer price relationship significantly worsened owing to the devaluation of the kwacha by 300 percent and the dismantling of fertilizer subsidies. Benson (1997) further concluded that the recommended levels of fertilizer use per hectare of maize were suboptimal even in years with above-average rainfall.

However, the production seasons 1993/94 and 1994/95, for which the survey recalled crop data, saw rainfall that was far below average. The first year experienced a drought in all areas, and some districts, such as Mangochi, again received little rainfall in the second year and experienced a complete failure of their crop, consisting mainly of hybrid maize. In other words, in years of below-average rainfall, the recommended fertilizer package that comes with the hybrid maize seed credit implies a considerable downside risk of low or even negative gross margins. Indeed, when we average the results for the two production seasons (including the drought year), the average gross margin per hectare of local maize is MK 627 and that for hybrid maize is MK 491 for all households.

Without any doubt, these results raise questions about the farm-level profitability of the credit services provided for growers of hybrid maize. This finding need not to be in conflict with the hypothesis that improved access to credit in general can increase productivity and gross margins per hectare—provided that agricultural loans

are given for growing hybrid maize, but with much lower and better-adapted levels of fertilizer and/or an improved maize-to-fertilizer price ratio, or given for growing more profitable crops, such as tobacco. Yet, as most agricultural loans during the survey years were used for hybrid maize and fertilizer, and since these years experienced below-average rainfall, their impact on the gross margins of the maize crop clearly appears to have been detrimental.

In conclusion—and keeping in mind that a tabular analysis can only suggest causal patterns but not confirm or reject them with statistical significance—participation in credit programs seems to induce growers to plant a higher share of hybrid maize and tobacco and to use seed, fertilizer, and pesticides with greater intensity. However, in the case of input-intensive hybrid maize in years of below-average rainfall, the recommended level of fertilizer use reflected in the credit package offered to farmers does not seem to be profitable at all. In other words, those who did not borrow seed and fertilizer for hybrid maize production did better than those who did during the two survey years.

Moreover, the government's input distribution programs during 1993/94, 1994/95, and 1995/96, offered as a response to the droughts in 1992/93 and 1993/94, had a sizable influence on the availability of inputs. This raises questions regarding the long-term sustainability of these efforts and their possible detrimental effects on the sustainability of the rural financial institutions, especially MRFC. Indeed, if households realize that they can get inputs for free, why should they get them with loans carrying interest rates of over 40 percent, or why should they bother repaying their loans? The negative and unintended effects of a policy of handouts of free fertilizer of course affect not only financial institutions but also the possible market entry and sustainability of private traders in agricultural inputs and produce.

Total Household Crop and Nonfarm Incomes

Table 15 shows that the average per capita total household income in the survey areas was MK 776 for 1995 and MK 587 for 1994. The average per capita crop income in the drought year of 1994 (MK 149) was less than half the average crop income for 1995 (MK 337). This shows the high income risk that agricultural households relying only on crop production must face in Malawi. On the other hand, nonfarm income-generating activities, which are less dependent on weather than farming, not only may be a less risky source of income but also seem to provide substantial income to rural households (30 percent more than the average crop income). However, there are large differences among rural households in their degrees of involvement in nonfarm income-generating activities. Female-headed households are more involved in such activities than male-headed ones (35 percent versus 27 percent of nonfarm incomes as a share of total household incomes, respectively). But their per capita incomes (farm and nonfarm) are lower than male-headed ones in both years.

Table 15 also shows that the average per capita total incomes of credit program participants in 1994 (MK 999) and 1995 (MK 1,308) are about twice as high as the ones for past participants (MK 474 and MK 679, respectively) and the ones for

Table 15—Total household farm and nonfarm income, 1994 and 1995, by credit program membership

	All households					Current program members								
	All	Male-headed	Female-headed	Tobacco farmers	Nontobacco farmers	MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All	Past members	Never been members
						(MK)[a]								
1994														
Total income														
Gross	2,665	3,106	1,762	3,252	2,600	5,097	4,133	4,044	4,800	9,930	7,354	5,160	2,469	2,175
Per capita	587	690	377	635	582	1,007	918	862	781	1,606	1,478	999	474	526
Crop income														
Gross	569	642	422	1,202	500	685	−142	1,518	466	2,158	3,296	722	860	467
Per capita	149	165	115	242	139	137	−63	310	75	346	725	141	170	146
1995														
Total income														
Gross	3,564	4,081	2,508	7,067	3,179	6,830	4,379	8,260	6,098	20,946	11,874	6,952	3,496	2,852
Per capita	776	860	602	1,254	723	1,319	993	1,535	960	3,160	2,260	1,308	679	684
Crop income														
Gross	1,469	1,616	1,168	5,018	1,079	2,418	104	5,734	1,764	13,174	7,817	2,514	1,887	1,144
Per capita	337	335	340	862	279	449	11	983	254	1,901	1,507	450	375	304
Nonfarm income[b]														
Gross	2,095	2,465	1,340	2,049	2,100	4,412	4,275	2,526	4,334	7,772	4,057	4,437	1,609	1,708
Per capita	439	525	262	392	444	870	981	552	706	1,259	753	858	304	381
Nonfarm income as average share of total income (percent)	29	27	35	34	29	41	47	31	78	62	63	52	29	25

Source: DRD/IFPRI Rural Finance Survey.

[a] US$1 = MK 15.

[b] Data on 1994 nonfarm income were not collected, but they are assumed to be the same as in 1995.

households who never participated in any credit program (MK 526 and MK 684, respectively). There are, however, significant differences among participants in the different credit programs in both years. In fact the MK 3,160 average per capita total income of PMERW2 participants in 1995 is more than twice as much as the ones for MRFC and MUSCCO and about three times the ones for MMF and PMERW1. Although the average per capita income of PMERW2 members in 1994 (MK 1,606) was about half of that in 1995, it was still significantly higher than that for members of the other programs. The lower average per capita incomes for MMF participants are, however, largely due to their negative or extremely low average per capita crop incomes (MK –63 in 1994 and MK 11 in 1995).[17]

The MUSCCO participants have the lowest average nonfarm income as a share of total household income (31 percent). The MRFC participants have the second lowest average share of nonfarm income (41 percent), which is lower than that of MMF participants (who receive loans for nonfarm income-generating activities) by only 6 percentage points. The average share of nonfarm income for MRFC participants challenges the conventional wisdom that views them as agriculture-focused households who earn most of their incomes from farming. On the other hand, the greater than 50 percent average share of nonfarm income for PMERW1 and PMERW2 members (78 percent and 62 percent, respectively) is consistent with the fact that they receive loans exclusively for nonfarm income-generating activities. The PMERW2 participants' lower average share of nonfarm income compared with PMERW1 members is largely due to their particularly high 1995 per capita crop income (MK 1,901), which, in average per capita terms, is more than seven times the income for PMERW1, about twice that for MUSCCO, four times that for MRFC, and more than 170 times that for MMF participants. This suggests that part of the profits from the nonfarm businesses created by PMERW2 participants may have been reinvested in their farm businesses. This hypothesis seems to be confirmed by the fact that not only did they have the highest average input expenditures per hectare among all participants in credit programs (Table 13), but most of their input expenditures (over 80 percent of total values in 1994/95) are self-financed out of their savings (Table 10).

This finding about the probable positive impact of loans for nonfarm income-generating activities on the profitability of farm businesses has implications for MRFC's loan policy toward smallholder farmers. The policy implications are even clearer when one considers the other findings that MRFC's participants earn, on average, 41 percent of their incomes from nonfarm income-generating activities, and that 81 percent of their agricultural input expenditures in 1994/95 were self-financed, compared with only 16 percent financed through in-kind loans from MRFC (Table 10). By giving its smallholder household participants loans for nonfarm income-generating activities, MRFC could enable them to diversify their farm and off-farm enterprises. This would reduce the smallholder farm's exposure to the unprofitable maize crop

[17] The negative and extremely low crop incomes for MMF participants included in the survey are due to the fact that they are all from Mangochi, where, because of the drought in 1994 and 1995, many households did not harvest any crops.

enterprise and consumption risks, and therefore increase its resilience and its ability to adopt new crops and technologies, which—as the data suggest—are largely financed by equity capital. MRFC's continued provision of in-kind loans instead of cash loans for farm and nonfarm activities at present leaves households little choice in finding out for themselves what is optimal for them given their specific constraints.

Household Consumption Expenditures and Calorie Intake

Table 16 presents data on average household consumption expenditures, calorie intake, and nutritional status. The total food expenditure figures include the imputed value of food out of home production. The average household per capita monthly consumption expenditure is MK 148. The average monthly expenditures for nonfood items are very low when compared with the corresponding values for food expenditures. Eighty-eight percent of consumption expenditure is, on average, for food, a clear reflection of the extreme poverty of many rural households in Malawi. Food as an average share of total cash expenditure in the survey areas is 70 percent. The average per capita daily intake in the sample is 2,199 kilocalories, which is almost the same as the 2,200 kilocalories per person per day recommended for Malawi (United Nations and Government of Malawi 1993). Daily calorie intake is noticeably lower for female-headed households than for male-headed ones.

Table 16 also shows that households who are members of formal credit programs have higher gross consumption expenditures compared with nonparticipants (MK 695 versus MK 568) but lower average per capita consumption expenditures (MK 136 versus MK 160), a finding that may be explained by the lower per capita expenditure levels of MRFC, MUSCCO, and PMERW1 member households relative to those of nonparticipants. In contrast, participants in PMERW2 and MMF have significantly higher average per capita consumption expenditures despite having relatively larger household sizes. The past participants have the lowest average per capita total expenditure (MK 107). However, their average per capita daily caloric intake is essentially the same as that of participants (1,895 kilocalories). At 2,336 kilocalories, the average per capita daily caloric intake of households who never participated in any credit program is higher than that of participants in any of the credit programs, including those in PMERW2, whose value of 2,077 kilocalories is second only to that of MUSCCO participants (2,145 kilocalories). These findings indicate that some of the participants may not be spending their increased income on food, or that, if they are, they are spending it on luxurious foods with relatively lower calorie content.

Household Nutritional Status

The prevalence of malnutrition among households' preschoolers is presented at the bottom of Table 16. The *Z*-score deviations from the median of the World Health Organization population reference for height-for-age and weight-for-age are used to measure malnutrition. Height-for-age is a measure of chronic malnutrition (stunting), while weight-for-age is a measure of acute or short-term malnutrition.

As measured by the height-for-age *Z*-scores, 43 percent of preschoolers are chronically malnourished. This is close to the 48.6 percent of stunted children under five years of age found in the 1992 Demographic and Health Survey (United Nations and Government of Malawi 1993). As measured by weight-for-age, 14 percent of preschoolers are acutely malnourished. Preschoolers from male-headed households seem to be more likely to be chronically malnourished than those from female-headed households (46 percent versus 37 percent).

Table 16 also shows that preschoolers in households who never participated in a credit program have the lowest prevalence of chronic and acute malnutrition (37 percent and 11 percent compared with averages of 47 percent and 17 percent for all participants, respectively). Past participants have the highest prevalence of both chronic and acute malnutrition (60 percent and 20 percent, respectively). The fact that participants in formal credit programs have a significantly higher prevalence of chronic malnutrition than households who never participated is probably due to self-selection. Indeed, chronic malnutrition or stunting, as measured by low height-for-age, is more than anything else a reflection of the effects of cumulative past nutritional deficiencies that could have mostly occurred before the households joined the programs (most current participants joined only within the past three years). Among participants, MMF members have the lowest prevalence of chronic malnutrition (41 percent) while PMERW1 ones have the highest (54 percent). MMF participants also have the lowest prevalence of acute malnutrition, along with PMERW2 participants (13 percent).

A notable and surprising finding from Table 16 is that households that grow tobacco appear to be more food insecure despite having significantly higher average per capita annual total income (MK 1,254 compared with MK 723; Table 15). Indeed, they have significantly lower average 1995 per capita daily caloric intake (1,769 kilocalories) compared with nontobacco households (2,235 kilocalories). They also have a higher prevalence of both chronic and acute malnutrition (68 percent and 15 percent compared with 40 percent and 14 percent, respectively). One may think that this is because income from tobacco is likely to be controlled by males, who may spend most of it on things not related to household food security. This hypothesis appears to be confirmed by the significantly lower average per capita food expenditure in tobacco households compared with nontobacco ones (MK 95 versus MK 131). However, the average monthly nonfood expenditure of tobacco households is significantly lower than that of nontobacco ones in both per capita and total terms (MK 12 versus MK 21 and MK 60 versus MK 73, respectively). Furthermore, the total household food expenditure is higher in tobacco households (MK 568) than in nontobacco ones (MK 505). The total monthly maize consumption is also higher (65 kilograms versus 53 kilograms), although there is practically no difference between the two types of households in per capita terms (12 kilograms versus 13 kilograms, respectively).

The most plausible explanation for the food insecurity and malnutrition of tobacco households seems to be a combination of lager than average household sizes because of the labor-intensive nature of tobacco growing and the high relative cost

Table 16—Consumption expenditures, calorie intake, and nutritional status, by credit program membership, 1995

	All households					Current program members								
	All	Male-headed	Female-headed	Tobacco farmers	Nontobacco farmers	MRFC	MMF	MUSCCO	PMERW1	PMERW2	Other	All	Past members	Never been members
Total expenditure (MK)[a]														
Gross	582	597	552	629	579	616	743	643	773	1,115	1,047	695	543	568
Per capita	148	159	126	107	151	126	164	122	131	175	216	136	107	160
Nonfood expenditure (MK)														
Gross	72	83	51	60	73	103	173	72	122	223	218	112	57	67
Per capita	20	24	12	12	21	23	43	13	22	36	46	23	12	21
Food expenditure (MK)[a]														
Gross	510	514	500	568	505	511	569	571	651	892	828	582	486	500
Per capita	128	135	113	95	131	103	120	109	109	140	169	113	96	139
Monthly maize consumption (kilograms)														
Gross	53	52	55	65	53	64	62	76	71	73	51	64	66	48
Per capita	13	13	13	12	13	12	13	14	12	11	11	12	13	14
Daily calories per capita (kilocalories)	2,199	2,256	2,082	1,769	2,235	1,797	1,940	2,145	1,942	2,077	2,044	1,895	1,895	2,336

Food self-sufficiency (percent)	43	44	41	50	43	37	29	61	33	30	38	39	52	42
Maize self-sufficiency (percent)	61	65	54	86	59	50	39	84	43	55	39	54	73	60
Food as average share of budget[a] (percent)	88	86	90	89	88	85	78	87	85	83	80	85	91	88
Food as average share of total cash expenditure (percent)	70	69	70	70	70	72	67	65	76	76	66	72	72	69
Nutritional status of preschoolers: proportion of *Z*-scores that are 2 standard deviation below reference for:														
Height-for-age (percent)	43	46	37	68	40	45	41	52	54	45	49	47	60	37
Weight-for-age (percent)	14	14	14	15	14	20	13	17	19	13	5	17	20	11
Household size	5	4	5	6	4	6	6	5	7	7	5	6	6	4
Adult equivalent population	3.5	3.6	3.5	4.3	3.5	4.8	4.3	4.3	5.7	5.8	3.9	4.8	4.3	3.5

Source: DRD/IFPRI Rural Finance Survey.

[a] Total food expenditure includes the imputed value of food out of home production.

of buying maize for consumption. Indeed, the average household and adult population sizes of tobacco farmers are 6 and 4.3 compared with, respectively, 4 and 3.5 for nontobacco farm households. Furthermore, the self-sufficiency indexes for both total food and maize consumption are higher in tobacco households (50 percent and 86 percent compared with 43 percent and 59 percent, respectively, for nontobacco households). This indicates that, despite their higher per capita income, tobacco households have greater difficulties buying enough of the additional maize they need to satisfy their consumption requirements. These difficulties result from maize markets that are thin because of a lack of surplus maize from smallholder farmers and an inadequate transportation infrastructure. The unreliability of the market for maize and its consequences for the food security of tobacco farmers seem therefore to justify the reluctance of smallholder farmers to allocate more land to tobacco at the expense of maize crops, despite its much higher gross margin per hectare.

Summary of Results from Tabular Analysis

To conclude this tabular analysis of the data and set the stage for the econometric analysis, we summarize the main findings.

Household asset ownership, especially land, is positively correlated with participation in credit programs, even though two of the programs (MMF and PMERW1) target poorer segments of the population. As the coverage of all microfinance institutions in the rural areas is quite low, the vast majority of rural households have no access to formal credit. The informal credit market appears very inactive compared with empirical evidence from other countries. Furthermore, borrowers tend to exhaust their formal credit lines more often than their informal ones, although the former are significantly higher. This finding suggests that the two forms of credit are imperfect substitutes since informal credit almost never carries any interest rate and appears to be the cheaper source of capital, if one ignores for the moment the possibility of nonpecuniary costs associated with the exchange of informal credit.

The descriptive analysis suggests that participation in nonagricultural and agricultural credit programs alike induces growers to plant a higher share of hybrid maize and tobacco, and to use seed, fertilizer, and pesticides more intensively, leading to higher yields for all crops. However, the higher agricultural productivity in participating households does not necessarily increase their gross margins and net crop income per hectare on average for all crops, and certainly not for hybrid maize in particular. This finding questions the optimality of the in-kind input package for hybrid maize as it is provided by MRFC, MUSCO, and MMF.

We do not detect any positive association between participation in credit programs and either household food security or household nutritional status. On the contrary, households who never participated in any formal credit program are revealed to be more food secure and less chronically and acutely malnourished. However, the evidence on the malnutrition side may be the result of self-selection and does not preclude the possibility that participation in formal credit programs has a positive

nutritional impact by improving the short-term nutritional status of households with chronically malnourished children.

In conclusion, from the tabular analysis we obtain mixed results regarding the association of improved access to credit and household welfare outcomes. Moreover, even obvious patterns of descriptive analysis would not yield a sufficient answer, for these patterns could be driven by socioeconomic characteristics of households other than membership in a credit program. The econometric analysis in the next chapter should enable a more definitive assessment of the relationship between access to credit and household welfare in Malawi.

CHAPTER 4

Econometric Analysis of the Impact of Access to Credit on Household Welfare

The question of how access to credit or its improvement translates into change in such household outcomes as agricultural output, income, and food security is central in many decisions regarding government- and NGO-supported credit programs. The standard practice in previous studies on the impact of access to formal credit has been to take the estimated marginal effects of either the amount of credit received or membership in a credit program as measures of the impact of access to credit on various household welfare outcomes. The shortcomings of this standard practice have been discussed elsewhere (see, for example, David and Meyer 1980; Feder et al. 1990; Zeller et al. 1996; Diagne 1999; Diagne, Zeller, and Sharma 2000). The shortcomings arise because of the fungibility and substitutability of credit from different sources and the endogeneity of credit demand and membership in credit programs.

The policy usefulness of using the credit-received variable to assess the impact of access to formal credit is limited unless one assumes that (1) all households in the program were credit constrained when they were receiving credit, (2) the program is their only source of credit, and (3) they cannot use own resources to finance their investments even partially (Feder et al. 1990). However, most households have access to some form of informal credit and use various savings options to transfer resources across time. Furthermore, the different sources of credit and ways of financing investments are likely to be substitutable to some degree. Therefore the amount of formal credit they are demanding, when it becomes available, is likely to reflect (at least partially) substitution away from the other sources of investment funds. These substitution effects alone make it inappropriate to identify the impact of access to formal credit with effects due to changes in formal loan size, even if the endogeneity of the latter has been appropriately dealt with.

There are two other reasons why it is inappropriate to use the amount borrowed to assess the impact of access to formal credit:

1. Some households may have access to sufficient credit lines from a program but may have decided not to borrow because it was not optimal for them to

do so. Yet the credit lines provided by the program to these nonborrowing households may still have a positive effect on their household outcomes (by allowing them not to engage in unproductive precautionary savings, for example), which would not be accounted for.

2. Some households may have received large amounts of credit with little or no marginal impact on their household outcomes because, at that level of credit use, the marginal impact of additional credit received may be negligible. But this negligible impact does not account for the positive effects of the "shields" and flexibility provided by the sufficient credit lines that allowed them to make optimal borrowing choices.

The same criticism applies to the common practice of identifying the effects of membership in a credit program on household welfare outcomes as the impact of access to formal credit on those welfare outcomes. The wider literature on program evaluation demonstrates that if the survey design, sample selection, and econometric analysis are appropriately carried out to resolve the problem of endogeneity of membership status and credit program placement, then the estimated partial effects of the membership status variable should correctly measure the average impacts of the program on the welfare outcomes (see, for example, Moffit 1991; Heckman and Smith 1995; Morduch 1997; Pitt and Khandker 1998). In fact, most of the recent literature on the difficulties of measuring the impacts of credit programs follows the program evaluation literature and concentrates on the statistical problems related to survey design, sample selection, and endogeneity of program placement. But the studies that emphasize the statistical problems that complicate the identification of program impacts usually neglect the substitution and fungibility issues that are to some extent specific to credit programs.

The program impacts measured through the membership status variable, however, do not measure the impacts of *access to formal credit* on the same welfare outcomes, and they may not even correlate with access to formal credit. There are at least two reasons why this is so:

1. Most microcredit programs provide an array of additional services besides credit (literacy classes, business training, family planning education, and so forth). Therefore, for these programs the measured "program impacts" on the welfare outcomes include the impacts due to change in behavior as a result of these educational services (Pitt and Khandker 1998).
2. Membership in a credit program does not guarantee access to its credit, especially when it is most needed. In fact, many group-based microcredit programs (including two of the five studied in the report) stipulate explicitly that at any point in time only half of the group members can have access to their credit.[18] Even in microcredit programs that do not have this rule, but operate within ad hoc or continuously evolving institutional arrangements (es-

[18] This is an incentive repayment device aimed at inducing the half that are not receiving loans to put pressure on the recipients to repay their loans. The nonrecipients will be able to borrow only once all recipients have fully repaid their loans, implying that nonrecipients will be waiting indefinitely in case of default.

pecially those that depend on short-term donor funding), members' access to credit is most of the time uncertain.[19]

In summary, because both the partial effects of credit received and membership status do not necessarily correlate with the benefit derived from gaining access to formal credit, they cannot be taken as measures of the effect of access to formal credit on household welfare outcomes. Therefore, to assess satisfactorily the impact of access to credit, the analysis departs from the standard practice and makes the distinction between *access to credit* (formal or informal) and *participation* (in formal credit programs or in the informal credit market). A household has access to a particular source of credit if it is *able* to borrow from that source, although for some reasons it may choose not to. The extent of access to credit from a given source is measured by the *maximum* amount a household can borrow (its *credit limit* or *credit line*) from that source. A household is participating if it is borrowing from a source of credit. The distinction between *access* and *participation* is also important because a household may benefit from mere access to credit even if it does not borrow. Indeed, with the option of borrowing, it can do away with risk-reducing but inefficient income diversification strategies (Eswaran and Kotwal 1990) and precautionary savings with negative returns (Deaton 1991).

Since within this framework *access to credit* and its *improvement* are identified respectively with a *strictly positive* and *increasing* credit limit, measuring the impact of access to credit reduces to measuring the effects of an increase in the credit limit on household behavioral and welfare outcomes. The marginal effects of the credit limit variable for formal credit on household welfare outcomes, controlling for the credit limit from informal sources as well as the credit demanded from both sources, measure the marginal impacts of access to formal credit. Furthermore, by controlling for both the level of access to credit and the amount of credit demanded from formal and informal sources, the changes in the welfare outcomes due to changes in the formal credit limit variables can be separated from the ones due to the substitution effects that arise when formal and informal credit are substitutable to some degree. Similarly, the direct effect of access to credit (that is, the effect arising from merely having access to formal credit) is separated from the indirect effect that arises when households exercise their options to borrow.

The Contract-Theoretic Framework of the Credit Market

Because the credit limit is the central concept in our methodology for quantifying the extent of household access to credit and the impacts that access has on its welfare outcomes, a model of loan transaction focusing explicitly on the concept is presented. The model follows the contract-theoretic view of loan transaction (see, for example, Freixas and Rochet 1997). We restrict ourselves to heuristic arguments because a complete and rigorous mathematical presentation and analysis are beyond

[19] As an example, members of one of the microcredit programs studied here, MMF, could not borrow from their organization for several months during 1995 because it was being incorporated into MRFC (see Chapter 3).

the scope of this report. Essentially the lender chooses the credit limit and the amount he wants to be repaid. The borrower then chooses the amount to be borrowed within the range set by the lender. The borrower also chooses ex post (that is, once the loan has been disbursed) whether and when to pay back the loan.

More precisely the lender chooses the pair $(b_{max}, \boldsymbol{R}^l(.))$, where b_{max} is the maximum amount he is *willing* to lend and $\boldsymbol{R}^l$ is a repayment function $\boldsymbol{R}^l$: $[0, b_{max}] \rightarrow \mathbb{R}$ that specifies how much, when, and under what conditions he wants to be repaid for any given loan size $b \in [0, b_{max}]$.[20] The lender then lets the potential borrower choose the optimal amount $b^* \in [0, b_{max}]$ he wants to borrow. In other words, the lender offers the contract $(b_{max}, \boldsymbol{R}^l(.))$ to the borrower, who accepts or rejects it by his choice of $b^* \in [0, b_{max}]$. The contract is accepted if b^* is strictly positive and rejected if $b^* = 0$.[21] Once the loan has been disbursed, the borrower chooses the timing and amount(s) of the actual repayment(s) R^b. Default occurs when $0 \leq R^b < \boldsymbol{R}^l(b^*)$.[22] Of course, in his choice of b_{max} the lender is constrained himself by the maximum amount he is *able* to lend to any borrower, b^a_{max}.[23]

We note that because of the possibility of default and the lack of effective contract enforcement mechanisms, lenders have incentives to restrict the supply of credit even if they have more than enough to meet a given demand and the borrower is willing to pay a high enough interest rate (Avery 1981; Stiglitz and Weiss 1981). Therefore from the borrower's point of view the relevant limit on supply is not the maximum the lender is *able* to lend, b^a_{max}, but rather the maximum the lender is *willing* to lend, b_{max}.[24] This maximum amount the lender is *willing* to lend is the borrower's *credit limit* and is the focus of our methodology for quantifying the extent of household access to credit and its impact.

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[20] Owing to fixed transaction costs, lenders in the formal and semiformal credit markets also have minimum loan sizes. That is, the amount to be borrowed is restricted to within an interval of the form $[b_{min}, b_{max}]$ with $b_{min} > 0$. Extension to this case is straightforward and there is no loss of generality in using 0 as a lower bound for loan sizes.

[21] We have abstracted from issues regarding collateral in order to simplify the exposition. One specification for $\boldsymbol{R}^l$ is the linear repayment function: $\boldsymbol{R}^l(b) = (1 + r)b$, where r is the interest rate endogenously chosen by the lender. A more general specification for $\boldsymbol{R}^l$ that allows state-contingent repayment of loans is $\boldsymbol{R}^l(b,\omega) = (1 + r)b + \eta(\omega)$, where ω is an element of the set of possible states of nature, Ω, and η: $\Omega \rightarrow \mathbb{R}$ is an exogenous real-valued random variable. State-contingent repayment of loans is also a very important feature of the informal credit market as documented by Udry (1995b).

[22] Note that this is only a sufficient condition for breaching the terms of the contract. Even if $R^b = \boldsymbol{R}^l(b^*)$, breach of contract may still have occurred if the timing of the repayment (possibly in partial amounts) does not correspond to what was specified in the contract. To simplify the notation we did not include the timing issues in the specification of the repayment function $\boldsymbol{R}^l(.)$.

[23] Some may argue that in reality it is the borrower who first asks for the loan. Then the lender, after having received the loan application, decides whether to grant the amount asked or offer a lesser amount. Furthermore, one can argue that a loan transaction often involves some bargaining. However, the sequence in which the loan transaction is initiated and whether or not bargaining is involved in the loan transaction are details that are not important for the characterization of the outcome of the loan transaction. What is important is that at the end it is the lender who offers a contract to the borrower who, according to his free will, decides to accept or reject the contract.

[24] The wedge between the maximum a lender is *willing* to lend to a given borrower and the maximum he is *able* to lend (that is, the difference $b^a_{max} - b_{max}$) represents the extent of the credit rationing that arises because of information asymmetry and contract enforcement problems.

Of course the lender's optimal choice of credit limit b_{max}, which is interpreted here as the supply of credit, is a function of the maximum he is able to lend, b^a_{max}.[25] It is also a function of the lender's subjective assessment of the likelihood of default and of other borrowers' characteristics. However, this function is not a supply-for-credit function in the traditional sense of the term; under the assumption of price-taking behavior, the supply-for-credit function represents the schedule of what the lender is willing to lend as the market interest rate varies. This traditional supply function for credit is not defined in this context, in which the lender himself chooses the interest rate. Similarly, the optimal interest rate r chosen by the lender is a function of b^a_{max}, the lender's subjective assessment of the likelihood of default, and of other borrowers' characteristics. The reader is referred to Avery (1981) and Stiglitz and Weiss (1981), respectively, for an empirical and a formal analysis of how the lender's assessment of the likelihood of default affects the optimal choice of both b_{max} and r.[26] On the other hand, the function defining the borrower's optimal choice of loan size b^* is a demand-for-credit function in the traditional sense of the term (that is, the schedule of what the borrower is willing to borrow when the interest rate varies). The fact that b^* is a function of b_{max} in addition to being a function of the interest rate is merely a reflection of the borrowing constraint and of imperfect information. However, because of imperfections in the enforcement of the loan contract and the resulting adverse selection, the demand for credit need not be a downward-sloping function of the interest rate. Hence, as pointed out by Stiglitz and Weiss, lenders cannot use the interest rate as a way of rationing credit.

Observability of the Credit Limit and Expectations of Borrowers

The foregoing observations suggest that the credit limit a borrower faces depends on both the lender's and the borrower's characteristics and actions. But it also depends on random events that affect the fortune of lenders and other potential borrowers (who may compete with the borrower for the same possible credit). For example, one can expect the occurrence of drought in a rural agriculture-based economy to reduce the supply of informal credit while also increasing the number of people looking for loans. Hence the credit limit facing a potential borrower is a random variable whose value is determined by a number of events, some under the borrower's control, others under the lender's control, and still others outside the control of both.

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[25] For simplicity we are abstracting from issues related to how b^a_{max} for formal loans is determined by conditions in the market for on-lending funds (the possibility of raising capital from savers and/or the central bank, the determination of interest paid on savings, regulations of the central bank, and so forth).

[26] Within the framework of Stiglitz and Weiss (1981), the optimal interest rate r ($\hat{r}^*$ in their notation) is the interest rate that maximizes the lender's expected return from lending to a borrower, taking into account the possibility of default. It is this expected return that determines b_{max} (for a given level of b^a_{max}). Avery (1981) also uses the same expected return concept to justify the existence of credit limits for borrowers. His arguments and his econometric specification of the determinants of borrowers' credit limits were based mostly on interviews with loan officers in New Jersey.

The fact that b_{max} depends on random events also implies that its realized value at the times when borrowing actually takes place cannot be known exactly in advance by either the lender or the borrower. The fact that it cannot be known in advance by the borrower is clear since it will ultimately be the result of the lender's choice (although the borrower can influence that choice to some extent). The borrower can only form expectations about the likely value of b_{max} at the time of actual borrowing. But formal lenders usually provide enough information about their loan policy (eligibility criteria, types of projects funded, collateral and down payment requirements, and so forth) to enable potential borrowers to form reasonably accurate expectations about their b_{max} from each source of formal credit. In the cases of NGO- and government-supported credit programs, they usually even set and announce fixed credit limits for all potential borrowers.

Furthermore, at the time of borrowing it is only the lender who observes the realized value of b_{max} (which he himself determines), and he may or may not have the opportunity to reveal it to the borrower. For example, if the borrower's realized optimal choice of loan size is strictly positive but strictly less than the realized value of b_{max}, then the lender may never have the chance to tell the borrower his actual realized choice of b_{max}. Clearly, if at a particular time a borrower does not ask for a loan from a given source of credit, he will never learn, even in retrospect, about his realized b_{max} from that source of credit at that time (there may be exceptions in the cases of NGO- and government-supported credit programs that set and announce fixed credit limits for all potential borrowers). However, the potential borrower will always have expectations as to what would have been the likely value of b_{max} at that time. In fact it is precisely the borrower's prior expectations about the likely value of b_{max} and its variability that influence his behavior and make him decide whether or not to seek a loan from that particular source of credit. For example, in the direct method of detecting credit constraint used by Feder et al. (1990), Jappelli (1990), and Zeller (1994), the classification of borrowers usually includes a class of "discouraged borrowers." These discouraged borrowers did not seek any loan because either they *expected* to face a zero or very low b_{max} or they *expected* a relatively high cost (including transaction costs) for getting loans. The discouraged borrowers may have been wrong in their expectations and could perhaps obtain worthwhile loans at reasonable costs. But, whether they are wrong or right, in the end it is those expectations about their b_{max} that have determined their behavior, not the realized values of their b_{max} that will remain unknown to them. Even when a borrower seeks a loan from a given source of credit, the realized value of the optimal loan size is largely determined by his expectations about his b_{max} (especially if he has reasonably accurate information that allows him to predict well the *location* of b_{max}).

The arguments in the previous paragraphs imply that in the analysis of the demand for credit the borrower's expectations about b_{max} are more important than the realized values of b_{max} in determining the amounts of credit actually demanded. However, from a policy point of view, what might be of interest is not the borrower's response to change in his expectations about b_{max} but his response to change in b_{max} itself, since it is the variable under the lender's control and which determines access

to credit. It is the borrower's *expected* b_{max} from different sources of credit that is used in our analysis because the survey did not collect the realized values of b_{max}, which only lenders could provide with reasonable accuracy. The survey was focused on the demand side of the credit market, and for a relatively large survey it is not feasible to interview the lender for each loan transaction. Moreover, borrowers may not be willing to identify their informal lenders or may refuse to be interviewed if they know that the latter are going to be interviewed as well. However, with an econometric analysis it is possible to estimate and evaluate the impact of b_{max} on b^* and other household choice or outcome variables based solely on *expected* b_{max}. For this to be possible it is necessary to assume that the realized b^* and other household choice or outcome variables depend only on *expected* b_{max} and not on higher moments of b_{max} and its realized value. This restriction is plausible if b_{max} does not vary much (so that its variance and higher centered moments are close to zero) and the borrower has reliable information that allows him to predict the location of b_{max} with reasonable accuracy (so that the realized value of b_{max} will have little influence on realized optimal choices). Under this restriction, the assessment of the impacts of b_{max} on household choice and outcome variables is the same as that of the impacts of *expected* b_{max} because of the linear property of the mathematical expectation operator that, as usual, is identified with the borrower's expectation process.[27]

Specification of the Econometric Model

Following the methodology described previously, the impacts of access to formal credit on household welfare outcomes are estimated using an econometric model of the determination of (1) the household's credit limits from formal and informal sources of credit, (2) the household's demand for formal and informal credits, and (3) the household's welfare outcomes of interest. The report focuses on three household welfare outcomes: income, food security, and nutritional status of children. Improvement of one or more of these outcomes is often the stated objective of microcredit programs. Food security is measured by daily calorie and protein intake, and the nutritional status of children is measured by their height-for-age and weight-for-age *Z*-scores. The determinants of farm and nonfarm incomes and of food expenditures are also estimated as part of the econometric model.

The equations for the credit limits, demands for credit, and income postulated below can be rationalized by a household utility maximization model in which the contractual relationships between the household and its lenders and the (imperfect) substitutability between formal and informal credit are explicitly recognized. The equations for the determination of calorie intake, protein intake, and nutritional sta-

[27] One can avoid making this restrictive assumption by using identification methods based on covariance restrictions to deal with the problem of unobserved b_{max} (Chamberlain and Griliches 1975; Rosenzweig and Wolpin 1994, 1995). This more elaborate econometric method for dealing with the problem of an unobserved variable, as in this situation, is not pursued here because of the already complicated estimation procedure implied by our sampling procedure and the model presented subsequently.

tus can be then deduced by extending the basic household utility maximization model into a Becker-type household production framework (see, for example, Alderman and Garcia 1994; Pitt and Khandker 1998). However, the lender-borrower contractual relationship described previously must be modeled within a dynamic framework that accounts for asymmetry of information in order for the expectation issues discussed earlier to be relevant and for the credit demand equations derived from the model to depend explicitly on the credit limits as specified subsequently. As already explained, a rigorous formal presentation and mathematical analysis of such a model is beyond the scope of this report. The formal and informal lenders' optimal choices for the credit limit and the borrower's optimal demanded credit derived from such a mathematical model will have the following general forms:

$$b^F_{\max} = f^F(x_1, z_1^F), \tag{1}$$

$$b^I_{\max} = f^I(x_2, z_1^I), \tag{2}$$

$$b^F = \min(b^F_{\max}, g^F(x_3, z_2^F, b^F_{\max}, b^I_{\max}, r^F, r^I)), \text{ and} \tag{3}$$

$$b^I = \min(b^I_{\max}, g^I(x_4, z_2^I, b^F_{\max}, b^I_{\max}, r^F, r^I)), \tag{4}$$

where, $b^F_{\max}$, $b^I_{\max}$, b^F, and b^I are the credit limits and amounts borrowed for formal and informal credits, respectively, and f^F, f^I, g^F, and f^I are real-valued functions. The x_is $i = 1, 2, \ldots, 4$ represent for each i a vector of household demographics and assets, community characteristics, and prices. The z^F and z^Is are vectors of formal and informal lender characteristics, and r^F and r^I are the interest rates charged by the formal and informal lenders, respectively.[28]

Note that

$$b^{*F} \equiv g^F(x_3, z_2^F, b^F_{\max}, b^I_{\max}, r^F, r^I)$$

and

$$b^{*I} \equiv g^I(x_4, z_2^I, b^F_{\max}, b^I_{\max}, r^F, r^I)$$

are the optimal amounts borrowed in the formal and informal credit markets when the borrower's respective credit constraints are ex post not binding. Note also that,

[28] Note that, because the credit limit is viewed as a random variable, the dependence of the functions in (3) and (4) on the *expected* credit limits is implicit. In other words, the optimal choice $b^*(\omega) \equiv \boldsymbol{g}(.,b_{\max},\omega)$ is a function of the random variable $b_{\max}$, not of its possible realized value $b_{\max}(\omega)$. This allows the borrower's optimal credit demand to be determined not only by the realized value $b_{\max}(\omega)$ at time of borrowing (which he may not know) but also by his expectations about the likely value of $b_{\max}$ and its variability, formed well in advance of the time of borrowing. But, as previously explained, what we end up estimating are equations of the form $b^*(\omega) \equiv \boldsymbol{g}(.,b_{\max},\omega) \equiv \hat{\boldsymbol{g}}(.,Eb_{\max},\omega)$, where E is the expectation operator. For ease of notation and simplicity, we will continue to use in the econometric analysis $b_{\max}$ instead of $Eb_{\max}$ and still refer to it as the credit limit. The assumption made previously provides another justification for this practice. However, the theoretical explanations regarding borrower behavior still refer to $b_{\max}$ viewed as a random variable.

unless perfect information is assumed, these optimal ex post credit demands, which are sometimes called "latent" credit demands, depend explicitly on the two credit limits.[29] Indeed, as explained previously, the credit limit facing a potential borrower is a random variable. Therefore, the borrowing constraint is a stochastic constraint that depends on the prevailing state of nature. This implies that whether and where the credit constraint will bind cannot be known for certain in advance. Thus forward-looking households may anticipate possible binding of their credit constraints and take precautionary measures (saving and income diversification, for example) to ensure that their consumption and/or production plans will not suffer unduly when this occurs (Deaton 1991). The household's *expected* credit limits dictate the nature and magnitude of the precautionary measures taken in anticipation of the possible binding of the credit constraints. The precautionary measures that are taken would in turn influence the amounts households end up borrowing.[30] For example, in a simple two-period decision framework in which borrowing takes place in the second period, lower expected second-period credit limits should be associated with more precautionary savings in the first period, which in turn should lead to less need for borrowing.[31]

Based on the model and the foregoing arguments, we postulate without loss of generality the following linear functions to facilitate the remainder of the discussion. The equations estimated in the econometric analysis are, however, nonlinear:

$$b^F_{\max} = \alpha_1 x_1 + \beta^F_1 z_1^F + \varepsilon^F, \tag{5}$$

$$b^I_{\max} = \alpha_2 x_2 + \beta^I_1 z_1^I + \varepsilon^I, \tag{6}$$

$$b^{*F} \equiv g^F(x_3, z_2^F, b^F_{\max}, b^I_{\max}, r^F, r^I) = \alpha_3 x_3 + \beta^F_2 z_2^F + \delta^F r + \gamma^F_1 b^F_{\max} + \gamma^I_1 b^I_{\max} + u^F, \tag{7}$$

$$b^{*I} \equiv g^I(x_4, z_2^I, b^F_{\max}, b^I_{\max}, r^F, r^I) = \alpha_4 x_4 + \beta^I_2 z_2^I + \delta^I r + \gamma^F_2 b^F_{\max} + \gamma^I_2 b^I_{\max} + u^I, \tag{8}$$

$$y = \alpha_5 x_5 + \beta_y z_y^F + \gamma^F_y b^F_{\max} + \gamma^I_y b^I_{\max} + \pi^F b^F + \pi^I b^I + v, \tag{9}$$

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[29] A reviewer suggested that we might have called these credit demands *constrained* latent demands because they are constrained by the asymmetry of information that makes them dependent on the future credit limits.

[30] The discussion in the previous section regarding the behavior of discouraged borrowers suggests that the actual amount borrowed b should in fact be given by a function of the form $b \equiv \min\{b_{\max}, b^*\}$ if $Eb_{\max} > k(b_{\max}, r, x, z) \geq 0$ and $b \equiv 0$ otherwise. Here k is a real-valued function of its arguments that defines a threshold value for the expected credit limit below which the household will not seek a loan (that is, $b = 0$) even if it has a positive *latent* credit demand and might have obtained a loan if it had sought one (that is, $b^* > 0$ and $b_{\max}(\omega) > 0$ for some ω).

[31] As pointed out by one reviewer, one could imagine situations in which more borrowing can take place in the first

where y is a generic household welfare outcome variable and x_5 is a vector of household demographics and assets, community characteristics, and prices; and r is the (transaction cost-adjusted) formal interest rate.[32] The αs, βs, γs, δs, and πs are the parameters to be estimated, and ε, u, and v are error terms.

Equations (5)–(9) constitute a recursive system of simultaneous equations. The necessary identifying restrictions and choice of instruments for each equation are discussed subsequently. Using equations (9), (7), and (8), one can obtain the total marginal effect of access to formal credit on any household welfare outcome, y, and its different components (direct effect, substitution effect, and indirect effect through borrowing):

$$\begin{aligned}
\frac{\partial E(y|x_5, z_y{}^F, b^F_{\max}, b^I_{\max}, b^F, b^I)}{\partial b^F_{\max}} &= \gamma^F_y + \pi^F\gamma^F_1 + \pi^I\gamma^F_2 \quad \text{if} \quad b^{*F} < b^F_{\max} \text{ and } b^{*I} < b^I_{\max} \\
&= \gamma^F_y + \pi^F + \pi^I\gamma^F_2 \quad \text{if} \quad b^{*F} \geq b^F_{\max} \text{ and } b^{*I} < b^I_{\max}. \qquad (10) \\
&= \gamma^F_y + \pi^F\gamma^F_1 + \pi^I \quad \text{if} \quad b^{*F} < b^F_{\max} \text{ and } b^{*I} > b^I_{\max} \\
&= \gamma^F_y + \pi^F + \pi^I \quad \text{if} \quad b^{*F} \geq b^F_{\max} \text{ and } b^{*I} > b^I_{\max}
\end{aligned}$$

As can be seen from equation (10), γ^F_y measures the direct marginal effect on y of merely having access to formal credit. It is important to note that γ^F_y can be different from zero for households whose credit constraints are not ex post binding.[33] Having a positive $b_{\max}$ is like having insurance against a binding liquidity constraint. The effects of this insurance should apply to both ex post constrained and unconstrained households.

It is hypothesized that this direct effect is positive for most welfare outcomes because, as argued previously, the option to borrow, even if not exercised, should reduce the household's (low- or negative-return) precautionary savings and needs for risk-reducing but inefficient income diversification strategies. However, gaining and maintaining access to a source of credit is rarely free of cost, as potential borrowers are often involved in gift-giving or bribing, or are required by group-based lending programs to attend regular and time-consuming meetings just to be eligible. Therefore, if these costs outweigh the direct benefits γ^F_y may end up being negative.

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period in anticipation of an expected tighter second-period credit limit. First-period borrowing can also be lower if the return to savings is raised as a result of an expected tighter second-period credit limit. Only a fully worked-out mathematical model can clarify the exact relationship between the credit limit and borrowing in different periods. What we are trying to stress here is that the amount borrowed in a given period (possibly zero) depends on prior expectations about the credit limit faced in that period (even if the borrower ends up not knowing the realized value of that credit limit).

[32] The interest rate for informal credit is not included in the model because 97 percent of recorded informal loans did not carry any interest rate.

[33] Note that equations (3)–(5) apply to both ex post constrained and unconstrained households and that the estimated coefficients will measure average marginal effects across both types of households.

The product $\pi^F \gamma_1^F$ measures the marginal effect of access to formal credit on *y* when the household exercises its option to borrow under an ex post nonbinding formal credit constraint. The parameter π^F measures the same effect, but when the formal credit constraint is ex post binding. Since γ_1^F is less than one, the effect is higher in absolute value in the latter case.

Under either borrowing condition, and assuming that the loan thus obtained is used in a productive investment, one can expect π^F to be positive for most welfare outcomes (at least in the long run). However, π^F may be negative in the short run for some welfare outcomes. For example, if the loan obtained is not enough for the intended investment, then the household may reduce its consumption to make up for the shortfall. This can lead to a negative π^F for calorie intake, for example.

The parameter π^I and the product $\pi^I \gamma_2^F$ measure the marginal effects of access to formal credit on *y* owing to substitutability between formal and informal credit under ex post nonbinding and binding formal credit constraints, respectively. They are *gross* substitution effects obtained without holding the household utility (or overall welfare) constant when access to formal credit is changed. Therefore, they include both the *pure* substitution effects (obtained by holding utility constant) and the income or welfare effects. By definition, the pure substitution effects do not have any (overall) welfare impact.[34] But, in this reduced form specification, they cannot be separated from the income or welfare effects.[35] Therefore, these gross substitution effects can be different from zero, but their signs in any welfare outcome equation can be either positive or negative depending on whether informal credit and formal credit are (gross) substitutes or complements (that is, the sign of γ_2^F) and how informal credit is related to the welfare outcome in question (that is, the sign of π^I).

Equation (10) shows directly the shortcomings of the standard practice of using the amount borrowed to measure impact. Indeed, if the amount borrowed was used to measure the marginal impact of access to credit on *y,* then one would obtain π^F. This is seen to imply the restrictions that (1) $\gamma_1^F = 1$ (that is, households are *always* credit constrained and would borrow the full amount of any increase in their credit lines),[36] (2) $\gamma_2^I = 0$ or $\pi^I = 0$ (that is, formal and informal credit are not substitutable or households do not use informal credit even if they have access to it), and (3) $\gamma_y^F = 0$ (that is, there is no benefit from merely having access to formal credit without borrowing). Similarly, the use of the membership status variable (which is implicitly part of z^F, the vector of formal lender characteristics) to measure the impact of access to credit on *y* implies the same restrictions along with the restriction that $\pi^F = 0$.

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[34] What is referred to here as the household overall welfare is the indirect utility or its money-metric equivalent; it is not affected, by definition, by the pure substitution effect. Household income, although treated here as a welfare outcome, is merely an input toward this overall household welfare and can be affected by the pure substitution effect. The other measures of household welfare used in the study (food security and nutritional status) can also be affected by the pure substitution effect because they constitute only part of the overall household welfare that includes the satisfaction derived from the consumption of nonfood commodities. However, the pure substitution effects on these three components of overall welfare should compensate each other so as to sum to zero.

[35] The two effects could be separated only if the equations were explicitly derived from a utility maximization model.

[36] That is, the probability for them to face a binding credit constraint is one.

Estimation of the Model under Choice-Based Sampling

If the sample were drawn randomly, given the foregoing identifying restrictions, the system could be estimated using standard simultaneous equation estimation methods in combination with Tobit estimation methods to take care of the censoring problem in the loan demand equations (Maddala 1983; Amemiya 1985). However, as discussed in Chapter 3, the sample selection was carried out by stratifying along the program membership status variable with random selection within each stratum. This amounts to choice-based sampling because the stratifying variable is endogenous. Under the circumstances discussed in Chapter 3, not only is choice-based sampling more cost efficient than straight random sampling, it also (provided the appropriate estimation methods are used) yields estimates with better statistical properties than those obtained under straight random sampling (Cosslett 1981, 1993; Manski and McFadden 1981; Amemiya 1985). The importance of correcting for choice-based sampling is documented in the literature (Cosslett 1993), and our own descriptive analysis and early regressions showed very significant differences between the corrected and uncorrected results.

It is shown in the appendix that the choice-based corrected equations for the credit limits, credit demands, and outcomes, allowing for truncated and censored dependent variables, are given by

$$\tilde{E}(b_i^{K_{\max}} \mid x_{1i}, z^K_{1v_i}, z(j_i)) = w^{K_{\max}}_{j_i a} G^{K_{\max}}(x_{1i}, z^K_{1v_i}, z(j_i); \theta^{K_{\max}}) \quad i = 1, \ldots, n, \tag{11}$$

$$\tilde{E}(b_i^{K} \mid b_i^{\max}, \bar{r}^F, x_{2i}, z_{2i}, z(j_i)) = w^K_{j_i nc} G^K(b_i^{\max}, \bar{r}^F, x_{2i}, z_{2i}, z(j_i); \theta^K) + \hat{w}^K_{j_i c} b_i^{K_{\max}} \quad i = 1, \ldots, n, \tag{12}$$

$$\tilde{E}(y_i \mid b_i^{\max}, b_i, x_i^y, x_{ie}^y, z_{2i}, z(j_i)) = w_{j_i} G^y(b_i^{\max}, b_i, x_i^y, x_{ie}^y, z_{2i}, z(j_i); \theta^y) \quad i = 1, \ldots, n, \tag{13}$$

where $K \in$ {Formal, Informal}. The $G(.;\theta)$ are nonlinear functions that are linear in the parameter θ with squared and cross-product terms for a limited number of variables (credit limits, amounts borrowed, and landholding); $\theta^{K_{\max}}$, θ^K, and θ^y are the vectors of parameters to be estimated in the respective equations; $b_i^{K_{\max}}$ and b_i^K are, respectively, the credit limit and the amount borrowed by household i in the K sector of the credit market; y is one of the outcome variables (total income, net crop income, nonfarm income, food expenditure, calorie intake, protein intake, weight-for-age Z-score, or height-for-age Z-score); $b_i^{\max} \equiv (b_i^{F_{\max}}, b_i^{I_{\max}})$; $\bar{r}^F$ is the interest rate associated with b_i^F; $z(j_i)$ is the vector of credit program dummy variables; $z^K_{1v_i}$ is the vector of characteristics of all sector K *potential* lenders present in village v_i of household i; $z_{1v_i} \equiv (z^F_{1v_i}, z^I_{1v_i})$[37]; z^K_{2i} is a subvector of the vector of characteristics of sector K lenders who gave loans to household i; $z_{2i} \equiv (z^F_{2i}, z^I_{2i})$; x_{1i}, x_{2i}, and x_i^y are sub-

[37] We note that some of the unobserved formal lender characteristics are being absorbed into the vector of program dummy variables $z(j_i)$, which is household and alternative specific. In other words, j_i or the corresponding program

vectors of household i's vector of demographics, assets, and community characteristics variables (including prices); and x_{ie}^{y} is a subvector of the vector of outcome variables in the system excluding y (x_{ie}^{y} is not included in the income equations).

The w_{jia}^{K}, w_{jinc}^{K}, w_{jic}^{K}, and w_{ji} terms in the equations are the probability weights that correct for the choice-based sampling and, in the case of the credit limits and the credit demand equations, for the truncation and censoring of the dependent variables. More precisely,

$$w_{j_i a}^{K} \equiv w_{j_i a}^{K}(x_i, r^F, z_i, z(j_i); \theta_1) \equiv \frac{\frac{H(j_i)}{Q(j_i)} \frac{n_{j_i a}^{K}}{n_{j_i}} p(j_i \mid x_i, r^F, z_i, z(j_i); \theta_1)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} \frac{n_{ja}^{K}}{n_j} p(j \mid x_i, r^F, z_i, z(j); \theta_1)}, \tag{14}$$

$$w_{j_i nc}^{K} \equiv w_{j_i nc}^{K}(x_i, z_i, z(j_i); \theta_1) \equiv \frac{\frac{H(j_i)}{Q(j_i)} \frac{n_{j_i nc}^{K}}{n_{j_i}} p(j_i \mid x_i, r^F, z_i, z(j_i); \theta_1)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} \frac{n_{jnc}^{K}}{n_j} p(j \mid x_i, z_i, z(j); \theta_1)}, \tag{15}$$

$$w_{j_i c}^{K} \equiv w_{j_i c}^{K}(x_i, z_i, z(j_i); \theta_1) \equiv \frac{\frac{H(j_i)}{Q(j_i)} \frac{n_{j_i c}^{K}}{n_{j_i}} p(j_i \mid x_i, r^F, z_i, z(j_i); \theta_1)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} \frac{n_{jc}^{K}}{n_j} p(j \mid x_i, r^F, z_i, z(j); \theta_1)}, \text{ and} \tag{16}$$

$$w_{j_i} \equiv w_{j_i}(x_i, z_i, z(j_i); \theta_1) \equiv \frac{\frac{H(j_i)}{Q(j_i)} p(j_i \mid x_i, r^F, z_i, z(j_i); \theta_1)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j \mid x_i, z_i, z(j); \theta_1)}, \tag{17}$$

where $H(j) \equiv n_j/n$ and $Q(j) \equiv N_j/N$, with n_j (resp N_j) being the size of the sample (resp population) stratum defined by program j, and n and N being, respectively, the total sample and population sizes; n_{ja}^{K}/n_j is the sample proportion of households in stratum j with access to sector K credit (that is, with $b_i^{K_{\max}}>0$); n_{jc}^{K}/n_j and n_{jnc}^{K}/n_j are the

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dummy variable stands for both the alternative choice of household i and the identity of the formal lender defining stratum j, including all of its unobserved attributes (see the following discussion on identification).

sample proportions of households in stratum j with binding and nonbinding sector K credit constraints, respectively (that is, with $b_i^{*K} \geq b_i^{K_{\max}}$ and $0 \leq b_i^{*K}, < b_i^{K_{\max}}$, respectively); $p(j|x_i,z_i,r^F,z(j);\theta_1)$ is the conditional probability of household i choosing alternative j, with $x_i \equiv (x_{1i},x_{2i})$; $r^F = (r_1^F, \ldots, r_{Jp}^F)$ with r_j^F being the interest rate charged by the credit program defining strata j; and $z_i \equiv (z_{1vi},z_{2i})$. The complete list of all the regressors in x_i, x_i^y, and z_i is given in Table 17.

Table 17—Regressors used in equations

$z(j_i)$ =	{MRFC, MMF, MUSCCO, PMERW1, PMERW2, past member}
$Z_{1_{v_i}}^F$ =	{Number of years of operation in the area for each program (MRFC, MMF, MUSCCO, PMERW1, and PMERW2)}
$Z_{1_{v_i}}^I$ =	{Proportion of area male-headed households, area average household adult population size, proportion of adult wage laborers in area, average years of schooling of adults over 17 years of age, area average landholding size, area average value of total household assets, number of wholesale buyers coming to village, proportion of area heads of households who migrated from another village}
Z_{2i}^F	{Formal loan weeks of delay before receipt, no conditions on formal loans dummy variable}
Z_{2i}^I =	{Informal loan weeks of delay before receipt, no conditions on informal loans dummy variable, informal loans with fixed due dates dummy variable}
$\{x_i, x_i^y\}$ =	{Tobacco household status dummy variable, formal loans past default status dummy variables, accumulated outstanding amounts of formal loans (MK), accumulated outstanding amounts of informal loans (MK), total hectares of household land, square of total hectares of household land, household cultivated land of total land owned, total value of all assets owned, share of value of assets held as land, share of value of assets in livestock, age of household head, male-headed household dummy variable, years of schooling of head, years of schooling of spouse, adult population between 15 and 64, dependency ratio (household size divided by population ages less than 15 or over 64), distance from village of parents of head, southern region dummy variable, 1994/95 recall period dummy variable, price of maize (MK/kilogram), price of cassava (MK/kilogram), price of beans (MK/kilogram), weighted price index of vegetables (MK/kilogram), weighted price index of meat/fish (MK/kilogram), weighted price index of drink, 1995 tobacco producer price (MK/kilogram), 1995 chemical fertilizer price (MK/kilogram), 1995 tobacco seed price (MK/kilogram), 1995 local maize seed price (MK/kilogram), 1995 hybrid maize seed price (MK/kilogram), no access to clean water dummy variable, ownership of latrine dummy variable, distance from house to under-five clinic, number of positive events in household, number of illnesses/accidents in household, number of deaths in household within last three years, number of illnesses and accidents in household in last three years, average number of weeks of sickness in household in last 12 months, distance to home of credit officer or extension worker, distance to post office, distance to trading center}

Identification of the Equations in the System

The credit limit, credit demand, and outcome equations previously presented constitute a recursive system of simultaneous equations with the exogenous variables constituted by the household demographics, assets, community characteristics, and lenders' characteristics appearing in all of the equations. Hence exclusion restrictions on these variables are needed for the system to be identified. As already discussed, the simultaneity of the credit limit variables (which are choice variables for lenders, not for borrowers) results from the fact that they are likely to be correlated with unobservable household characteristics absorbed into the error terms, u and v (the household's likelihood of default, for example). It is clear that any household demographics, community characteristics, and prices observed by the econometrician can be reasonably expected to be observable by informal lenders. The same is true to some extent for formal lenders, especially those that use group-based lending technology. In addition, these observables are likely to determine both the lenders' choices of credit limits and the borrowers' choices of loan sizes. Therefore, as argued by Udry (1995a), one should not expect to be able to find exclusion restrictions on the vector x_i to identify the credit demand equations. Pitt and Khandker (1998) also argued for the same lack of plausible exclusion restrictions on x_i for the purpose of identifying the outcome equations. They noted that in principle the interest rate on formal credit could be used as an identifying instrument for formal credit. But the lack of variations in the interest rate charged by the credit programs precluded such use. Therefore, they relied on a quasi-experimental sampling scheme that was designed to enable them to identify the marginal impact of formal credit received on various household welfare outcomes.

The main argument we use in this study to identify the credit demand equations is that not *all* relevant lender characteristics variables enter directly into the determination of the amount borrowed. In other words, some of the lender characteristics variables influence the amounts borrowed *only through* the effects they have in determining the borrower's credit limit, his decision to seek a loan, and his likelihood of having a binding credit constraint. Therefore, in the foregoing equations we have partitioned the full vector of lender characteristics in each sector K of the credit market into two subvectors: $z_i^K \equiv (z_{1v_i}^K, z_{2i}^K)$. The vector z_{2i}^K that appears in the credit demand equation is household specific and represents the relevant characteristics and actions of sector K lenders who were engaged in loan transactions with household i (including rejected loan applications). On the other hand, the vector $z_{1v_i}^K$ appearing in the credit limit equation is not household specific and represents a subset of relevant lender characteristics patterning to *all* sector K *potential* lenders that are in the same village as household i. Our argument for identification is that $z_{1v_i}^K$ affects $b_i \equiv (b_i^F, b_i^I)$ only through $b_i^{K\max}$, $w_{j_i c}^K$ and $w_{j_i nc}^K$.

In our earlier analysis we used the program dummy variables $z(j_i)$ as identifying instruments for the formal credit demand equations. But the program dummy variables play a dual role in the model. Indeed, they stand at the same time for the objects of choice for households and for the respective identities of formal lenders (and

for a way of capturing their unobserved attributes). In fact both roles are present in the estimation of the probability choices $p(j|x_i,z_i,r^F,z(j);\theta_1)$, where the program dummy variables $z(j)$ are used as alternative-specific regressors to control for unobserved attributes specific to each alternative and which can explain why a household prefers one alternative over another (for the justification of such use see, for example, Cosslett 1981, 1993; Manski and McFadden 1981).

The program dummies are also used as regressors in all the equations in the system to control for unobserved characteristics and practices of the programs that directly influence the behavior and welfare of their respective members. Indeed, credit programs usually provide additional educational services aimed at inducing behavioral changes that are thought to directly improve household welfare outcomes. These behavioral changes include alterations in the credit market behavior of households. For example, credit programs usually advise their members not to borrow from money lenders or from any other source.[38] However, the estimated effects of the program dummies in these equations also reflect the effects of the programs being targeted to particular segments of the population and the effects of self-selection of households into the programs of their choice. These three effects cannot be separately identified because our sample households have not been allocated randomly across the programs and they all had the choice to participate or not to participate in a program.[39] But, more importantly, the fact that the programs are objects of choice for the households means that the program dummies are potential sources of simultaneity bias that should disqualify them for use as instruments. In our earlier analysis we also used a subset of the household-specific lender characteristics vector z^I_{2i} to identify the informal credit demand equation. But, as pointed out by a reviewer, z^K_{2i} is also source of simultaneity bias because households choose their lenders.[40] Furthermore, since observing z^K_{2i} is conditional on household i having been involved in a loan transaction, its values are missing for households who did not seek loans.[41]

The rationale behind the use of $z^K_{1v_i}$ for identification is that *all* households living in the same village, whether borrowing or not, face the *same* group of *potential* lenders in that village. This fact is not invalidated by the existence of three types of households in the village: those that sought and obtained loans (that is, those with $b_i^* > 0$ and $b_i^{\max} > 0$), those that sought loans but were rejected (that is, those with $b_i^* > 0$ and $b_i^{\max} = 0$), and those that did not seek loans either because they

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[38] Numerous studies have also reported that participants in credit programs borrow frequently from informal lenders just to meet the inflexible repayment schedules of their organizations (see, for example, Hossain 1988 and Sinha and Matin 1998).

[39] Note that this would still be a problem if we used a random sampling scheme instead of the endogenous stratification. Indeed, the main problem is the self-selection of households in the *population* into the programs of their choice. Solving this problem would require a quasi-experimental sampling scheme including sample households who would be eligible to participate in the programs but would not be given the choice (Pitt and Khandker 1998).

[40] It is also more difficult to find exclusion restrictions within z^K_{2i} because all of its elements may influence directly the size of the loan sought by a borrower.

[41] We set their values to zero for the nonborrowing households in our earlier analysis (all of them were in the form of dummy variables).

did not want them or were discouraged (that is, those with $b_i^* = 0$ or with low *expected* $b_i^{\max}$). It is also not invalidated by the fact that households borrow from different lenders and the fact that some potential lenders may not be involved in any loan transaction. Indeed, households may face the same group of potential lenders but end up borrowing from different lenders in that group (or not borrowing at all) precisely because of (1) differences in their perception and appreciation of the characteristics of each potential lender and (2) the actions of some potential lenders (also determined by the characteristics of the latter).[42] Hence, $z_{1v_i}^K$ would still be a determinant of the behavior of household *i* in sector *K* of the credit market even if we exclude from $z_{1v_i}^K$ the characteristics of those lenders who had loan transactions with that household. Moreover, since $z_{1v_i}^K$ is not affected by household *i*'s choice of which potential lender to seek a loan from (which is not the case for z_{2i}^K), it satisfies the nonsimultaneity criterion for a valid instrument.

To satisfy our exclusion restriction we include in $z_{1v_i}^K$ only those characteristics of potential lenders that affect the size of b_i only through the credit limit $b_i^{K\max}$ and through household *i*'s decision to participate in sector *K* of the credit market (that is, through $w_{j_iC}^K$ and $w_{j_inC}^K$). The formal lender characteristics included in $z_{1v_i}^F$ are the number of years each one of the credit programs has been operating in village v_i (with a zero value for a program not operating in that village). Indeed, most credit programs start with the same low credit limit for all borrowers. However, the credit limits of borrowers who repay on time are usually increased as time goes by while defaulters are excluded from the programs. It is only through these effects on the credit limit and the participation decision of households (initially and subsequently) that the age of a credit program in a village affects the amounts borrowed by households in that village.

For informal loans, we take all the adult population of the village as potential lenders. Indeed, the community survey showed that there are very few moneylenders in Malawian villages. In fact, as discussed in Chapter 3, 93 percent of the informal loan transactions recorded in the survey were between friends and relatives, with almost all living in the same village (76 percent of cases). The characteristics of a village adult population that we consider to be most relevant and appropriate for inclusion in the informal lender characteristics profile $z_{1v_i}^I$ are the proportion of adult wage laborers, the proportion of tobacco-growing households, the proportion of heads of households who migrated from another village, the proportion of male-headed households, the average household adult population size, the average years of schooling of adults over 17 years of age, the average landholding size, and the average total value of household assets.[43] To limit further the potential for simultaneity bias we computed *n* area averages for each lender characteristic with each average *i* excluding the corresponding values for household *i*.[44]

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[42] The choice of credit limits and interest rates is a part of those actions.

[43] In fact, the proportions and averages are taken across the cluster of villages (between 1 and 5) that make up what we call an area in the geographical stratification used in the survey. The areas were constructed so as include all the members that belonged to the same credit group.

[44] In practice the differences from the averages that include the values from all households go to zero as the area sample size increases (except for large outliers).

The same exclusion restrictions on the formal and informal lender characteristics variables are used to identify the outcome equations. In other words, the village-level lender characteristic variables $z^F_{1v_i}$ and $z^I_{1v_i}$ are considered to affect household welfare outcomes only through the respective credit limit variables. The vectors $z^F_{1v_i}$ and $z^I_{1v_i}$ are also used as instruments for the program dummy variables in the estimations of the informal and formal credit limit equations, respectively.[45] Since these restrictions alone are not enough to identify the outcome equations, we use additional reasonable exclusion restrictions on x_i, the vector of household demographic, community characteristic, and price variables. Instead of discussing here the restrictions on x_i used in each outcome equation and in the credit limit equations, for details we refer the reader to the list of variables used in each equation and to the tables of results.

Two-Step Limited Information Maximum Likelihood Estimation of the Identified System

With each equation in the system of equations (11)–(13) identified as discussed previously, a two-stage estimation method similar to Heckman's two-step procedure for Tobit models is used to estimate the parameters in the system. In the first stage the Manski-Lerman weighted maximum likelihood estimator is used to consistently estimate θ_1 and the conditional probability choices $p(j|\, x_i, z_i, r^F, z(j); \theta_1)$ that are used to construct estimates of the probability weights $w^K_{j_i a}$, $w^K_{j_i nc}$, $w^K_{j_i c}$, and w_{j_i}. In the second stage the estimated probability weights are used in (11)–(13) to estimate each resulting equation using Limited Information Maximum Likelihood (LIML) methods.

The first stage of the estimation uses a four-alternative two-level nested multinomial logit model (see the appendix for details). However, the model allows the vector of parameters to be different across the four alternative choices (Schmidt and Strauss 1975; Maddala 1983; Judge et al. 1985). At the first level of the nesting, the choice is between participation and nonparticipation in a credit program. At the second level, which is reached only if participation is the chosen alternative, the choice is between (1) joining and remaining a member of MRFC, (2) joining and remaining a member of the second program, and (3) joining either MRFC or the second program and then dropping out of the program (that is, becoming a past member). The classification defined by the four mutually exclusive alternative choices corresponds exactly to the stratification used in selecting the households. In each village there are at most two credit programs operating: MRFC and one of the other three programs that, as the choice variable, is generically called the second program in the model. However, the program dummy variables (MMF, MUSCCO, and PMERW) were used as alternative-specific regressors instead of the generic label. As usual in a multinomial discrete choice model, these dummy alternative-specific variables control for unobserved attributes specific to each alternative that can explain why a household

[45] No element of the household-specific lender characteristic vectors z^F_{2i} and z^I_{2i} was used in our final specification owing to identification and multicollinearity problems.

prefers one alternative over another.[46] In fact, for PMERW, its two sister programs (designated here as PMERW1 and PMERW2) are differentiated by their attributes and target groups.

Finally, the estimation procedure followed McFadden's (1981) sequential maximum likelihood estimation for nested multinomial logit models. Because of the sequential nature of McFadden's procedure, the usual maximum likelihood standard errors are not valid. Therefore, the bootstrap method (Efron and Tibshirani 1993; Jeong and Maddala 1993), implemented by replicating (with replacement) exactly the sampling procedure used to select the households, was used to calculate standard errors for all the estimated conditional probability choice parameters and the ones for the subsequently estimated system of simultaneous equations. To account for the possibility of the instruments being only weakly correlated with the endogenous variables, for each equation the relevant *F* statistics and exogeneity and overidentification test statistics were computed following Staiger and Stock (1997).

The estimations of the probability choice model and that of the system of equations as well as the computations of the partial effects were programmed using GAUSS. The partial effects were first calculated for each household before taking weighted averages across all households. This is preferable to evaluating partial effects at the means because of the nonlinearities in the probability choices and the equations in the system. If the functional dependence of a right-hand-side variable y in the system on another continuous variable x in the system includes a functional dependence through another dependent variable z in the system, then the partial effect on y resulting from a marginal change in x, $\partial E(y|x,.)/\partial x$, includes the partial effect from the induced change in z calculated as $(\partial E(y|z,.)/\partial z)\times(\partial E(z|x,.)/\partial x)$. This induced partial effect, which we call *indirect effect* in the discussion of the results, is calculated and shown separately in the tables of results before being added to the direct effect resulting from the eventual direct dependence of y on x (that is, not through another variable). For a dummy variable d, the partial effect for the ith household is calculated as $E(y_i|d_i=1) - E(y_i|d_i=0)$ ($p(j_i|d_i=1) - p(j_i|d_i=0)$ for the program participation probabilities), holding all the other independent variables constant at their observed values. But, when d is one of the program dummies, the values for the other program dummy variables are all set to zero to respect the mutual exclusivity of program participation (otherwise some of the households would be made to belong to more than one program).[47]

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[46] Again see Cosslett (1981, 1993) and Manski and McFadden (1981).

[47] The calculation of the partial effects, while conceptually straightforward, has not been easy to implement. Writing the GAUSS codes for its implementation has been the most time-consuming part of the estimation, owing to the multiple levels of nesting in the model and to the need to have the program automatically make the distinction between a continuous variable and a dummy variable and do what is required for the program dummy variables. A manual distinction between a continuous variable and a dummy variable using the variable names is not feasible because of the large number of variables involved and the numerous changes in model specification usually required before one arrives at a final specification.

CHAPTER 5

Results of the Econometric Analysis

The system of equations (5)–(9) was estimated using the two-stage methodology outlined in Chapter 4. The data used in the econometric analysis are aggregated household-level data. The credit limit and the credit demand equations are based on four recalled periods (see Chapter 3); this is the reason that the number of observations in Table 18 is given as 1,508. The income equations are based on annual (1994/95) data. The other equations are based on the three recalled periods defined by the three rounds of the survey. The results of the estimation are presented in Tables 19–32. The estimates of the parameters in the system are included in the presentation of the results but are not discussed; the discussion focuses instead on the partial marginal effects of the variables of interest that are more readily interpretable because of the nonlinear nature of the equations. Moreover, owing to space limitations not all the variables included in the estimation are included in the tables of results.

For each equation, the relevant *F* statistics and exogeneity and overidentification test statistics are presented in the relevant table of results. We note in particular that the *F* statistic for the joint significance of the formal lenders' characteristics in the formal credit limit equation ($F_{5,1503} = 3.21$) and that for the joint significance of the informal lenders' characteristics in the informal credit limit equation ($F_{5,1503} = 2.72$) are both relatively low. Hence the formal and informal lenders' characteristic variables may be sources of bias in the LIML and two-stage estimates and diagnostic test statistics owing to their weak correlations with the credit limits (Staiger and Stock 1997). Therefore, as recommended by Staiger and Stock (1997), we use the Durbin and Basmann tests for testing the exogeneity and overidentification restrictions, respectively. As the tables show, the null hypothesis of exogeneity of the presumed endogenous variables was rejected by the Durbin test in all the equations except that for the informal credit demand. The overidentifying restrictions are also rejected by the Basmann test in all the equations except that for the formal credit limit. Hence the ordinary least squares (OLS), two-stage least squares (TSLS), and LIML methods are all likely to yield biased estimates in most equations. All the equations were estimated using all three methods. But because the differences among the three sets of results were not substantial and because of the number of equations and vari-

Table 18—Definition and summary statistics of variables used in the model

	N	Minimum	Maximum	Mean	Standard deviation
1994/95 recall period dummy variables	1,508	0.00	1.00	0.75	0.43
1995 hybrid maize seed price (MK/kilogram)	1,508	0.70	7.00	3.88	1.36
1995 local maize seed price (MK/kilogram)	1,508	0.33	2,000.00	16.97	105.63
1995 chemical fertilizer price (MK/kilogram)	1,508	0.94	6.67	2.13	0.84
1995 tobacco producer price (MK/kilogram)	1,508	2.00	30.00	12.17	3.99
1995 tobacco seed price (MK/kilogram)	1,508	0.12	4.50	1.40	0.41
Accumulated outstanding amount of informal loans (MK)	1,508	0.00	580.00	2.64	28.34
Accumulated outstanding amount of formal loans (MK)	1,508	0.00	6,767.00	86.82	343.92
Adult population between 15 and 64 years of age	1,508	0.00	8.00	2.53	1.24
Age of household head	1,508	20.00	86.00	45.82	13.76
Area average value of total household assets	1,508	82.44	838.64	269.18	181.10
Area average landholding size	1,508	1.00	2.33	1.75	0.34
Area average household adult population size	1,508	1.46	2.79	2.23	0.36
Average number of weeks of sickness in household in the last 12 months	1,508	0.00	17.33	1.01	1.92
Average years of schooling of adults over 17 years of age	1,508	0.86	6.64	3.79	1.64
Daily wage contract dummy variable	1,508	0.00	1.00	0.09	0.29
Dependency ratio (household size divided by population ages less than 15 or over 64)	1,508	0.00	1.00	0.49	0.22
Distance to home of credit officer or extension worker	1,508	0.00	15.00	2.33	3.75
Distance to post office	1,508	0.00	26.00	6.64	7.70
Distance to trading center	1,508	0.00	15.00	5.04	5.16
Distance from house to under-five clinic	1,508	0.00	19.00	3.72	3.46
Distance from village of parents of household head	1,508	0.00	700.00	30.03	94.02
Fixed work contract dummy variable	1,508	0.00	1.00	0.09	0.29
Formal loans past default status dummy variables	1,508	0.00	1.00	0.12	0.32
Household per capita daily protein intake	1,508	6.08	751.67	79.15	57.89
Household per capita crop income in 1994/95 season (MK)	1,508	−161.00	10,985.00	571.79	1,089.67
Household per capita total formal loans received (MK)	1,508	0.00	9,025.00	160.56	546.13
Household per capita daily calorie intake (kilocalories)	1,508	241.18	9,654.11	2,033.16	934.87
Household per capita informal credit limit (MK)	1,508	0.00	5,200.00	127.14	268.24
Household per capita informal loans received (MK)	1,508	0.00	1,000.00	13.57	60.90
Household per capita nonfarm income in 1994/95 season (MK)	1,508	0.00	6,154.00	218.58	499.38

(continued)

Table 18—*Continued*

	N	Minimum	Maximum	Mean	Standard deviation
Household per capita total income in 1994/95 season (MK)	1,508	–29.00	13,413.00	1,187.84	1,549.23
Household per capita monthly food expenditure (MK)	1,508	0.30	23.68	3.91	2.92
Household per capita formal credit limit (MK)	1,508	0.00	11,000.00	336.10	824.78
Index of crop risk (1–9)	1,508	5	10	7.78	1.53
Male-headed household dummy variable	1,508	0.00	1.00	0.72	0.45
MRFC program dummy variable	1,508	0.00	1.00	0.22	0.42
MMF program dummy variable	1,508	0.00	1.00	0.07	0.25
MUSCCO program dummy variable	1,508	0.00	1.00	0.07	0.26
No access to clean water dummy variable	1,508	0.00	1.00	0.38	0.49
Number of years of MRFC operation in area	1,508	1.40	14.80	7.00	4.89
Number of years of MMF operation in area	1,508	0.00	3.80	0.42	1.02
Number of years of MUSCCO operation in area	1,508	0.00	6.50	1.52	2.29
Number of wholesale buyers coming to village	1,508	0.00	4.00	0.98	1.22
Number of deaths in household within last three years	1,508	0.00	2.00	0.27	0.46
Number of years of PMERW2 operation in area	1,508	0.00	3.00	1.04	1.13
Number of illnesses and accidents in household	1,508	0.00	4.00	0.18	0.49
Number of positive events in household	1,508	0.00	8.00	0.39	0.80
Number of years of PMERW1 operation in area	1,508	0.00	3.90	1.71	1.77
Number of illnesses and accidents in household in last three years	1,508	0.00	5.00	0.17	0.51
Ownership of latrine dummy variable	1,508	0.00	1.00	0.81	0.39
Past member	1,508	0.00	1.00	0.23	0.42
PMERW1 program dummy variable	1,508	0.00	1.00	0.16	0.36
PMERW2 program dummy variable	1,508	0.00	1.00	0.09	0.29
Price of beans (MK/kilogram)	1,508	3.70	25.00	8.21	2.90
Price of cassava (MK/kilogram)	1,508	0.55	6.45	2.79	1.52
Price of maize (MK/kilogram)	1,508	0.08	6.16	1.56	0.91
Proportion of area male-headed households	1,508	0.31	0.93	0.68	0.15
Proportion of area heads of household who migrated from another village	1,508	0.03	0.62	0.23	0.15
Proportion of adult wage laborers in the area	1,508	0.00	0.16	0.07	0.05
Share of value of assets in livestock	1,508	0.00	1.00	0.13	0.20
Share of value of assets held as land	1,508	0.00	1.00	0.51	0.25
Share of household cultivated land out of total land owned	1,508	0.00	100.00	81.35	19.02
Share of value of household productive assets owned by spouse	1,508	0.00	1.00	0.40	0.46

(continued)

Table 18—*Continued*

	N	Minimum	Maximum	Mean	Standard deviation
Share of acres of household land owned by spouse	1,508	0.00	1.00	0.40	0.46
Southern region dummy variable	1,508	0.00	1.00	0.24	0.43
Tobacco household status dummy variable	1,508	0.00	1.00	0.19	0.39
Total hectares of household land	1,508	0.10	13.20	1.96	1.41
Total value of assets owned	1,508	130.00	79,991.00	2,172.11	4,444.17
Transaction cost–adjusted formal interest rate	1,508	0.00	2.96	0.34	0.20
Transaction cost–adjusted average interest rate of MRFC/SACA	1,508	0.24	0.43	0.35	0.05
Transaction cost–adjusted average interest rate of other programs	1,508	0.48	0.51	0.50	0.01
Weekly/monthly wage contract dummy variable	1,508	0.00	1.00	0.12	0.32
Weighted price index of drink	1,508	2.08	53.60	12.39	9.52
Weighted price index of meat/fish (MK/kilogram)	1,508	0.75	16.01	8.40	3.04
Weighted price index of vegetables (MK/kilogram)	1,508	0.11	6.89	2.20	0.98
Weighted price index of oxen	1,508	450	3,000	1,832.27	519.53
Weighted price index of cattle	1,508	95	3,000	814.67	497.28
Weighted price index of goats	1,508	26	255	90.53	38.25
Weighted price index of chickens/ducks	1,508	5	5,106	234.40	764.16
Years of schooling of household head	1,508	0.00	12.00	4.20	3.32
Years of schooling of spouse	1,508	0.00	10.00	3.14	3.05

Note: All the data are aggregated household-level data. The credit limit and the credit demand equations are based on four recalled periods (see Chapter 3). This is the reason for the 1,508 number of observations shown in the table. The income equations are based on annual (1994/95) data. The other equations are based on the three recalled periods defined by the three rounds of the survey.

ables involved, the results reported and discussed here are based only on the LIML parameter estimates in order to save space.[48]

Determinants of Participation in Credit Programs

The predicted conditional probability choices are presented in Table 19, and the parameter estimates of the conditional probability choice estimation and the partial

[48] In many cases there was no difference at all in the estimated parameters. Furthermore, there are no qualitative differences in the interpretation of the results and conclusions derived using the LIML, OLS, or TSLS sets of estimates. We also estimated all the equations using the total household amounts instead of the per capita amounts for the credit limits and credit received by the households, as suggested by a reviewer, but we found no qualitative differences between the two sets of estimates. The reported results are based on the per capita amounts because they are easier to interpret.

Table 19—Predicted conditional probability choices

Conditional probability of:	
Not participating	0.34 (0.020)
Participating	0.66 (0.020)
Conditional on participating, probability of being:	
A member of MRFC	0.36 (0.015)
A member of MMF, MUSCCO, PMERW1, or PMERW2	0.28 (0.03)
A past member	0.36 (0.019)

Note: Standard errors are given in parentheses.

changes in the probability choices are presented in Table 20. Table 19 shows that there is a 66 percent chance that a household will participate in a credit program. Once a household has decided to participate, the chances are 36 percent that it will join and stay with MRFC, 28 percent that it will join and stay with one of the other four programs (MMF, MUSCCO, PMERW1, or PMERW2), and 36 percent that it will join a credit program and then drop out (either voluntarily or by defaulting).

Table 20 shows the absolute partial changes in the four probability choices after marginal changes in the independent variables. First, controlling for all other factors, the unobserved specific program attributes picked up by the program dummies have statistically significant influences on the average household's decision to participate. However, it is the ones for MRFC that have the greatest influence (11 percent absolute increase in the probability of participating compared with 7 percent for PMERW, 6 percent for MMF, and 3 percent for MUSCCO).[49] Once the decision to participate has been made, the unobserved specific program attributes have statistically significant effects on the choice of a specific program to join or to leave after joining. Everything else being equal, MRFC's unobserved specific attributes increase the probability of joining and staying with MRFC by 27 percent in absolute terms and reduce that of joining a second program and that of leaving MRFC by 12 percent and 15 percent in absolute terms, respectively. The corresponding figures for the second program choice are generally lower. For example, PMERW's attributes, which have the strongest effects, increase the probability of joining and staying with the second program (instead of MRFC) by 20 percent in absolute terms and reduce (in absolute terms) that of joining MRFC by 10 percent and that of leaving the second program by 10 percent. The opposite directions of these effects are reflections of the mutual exclusivity of the three choices. Table 20 also shows that, at current levels of participation, the longer presence of a program in an area does not increase the likelihood of households joining it. On the contrary, except for the PMERW2 program, there is a negative (though not statistically significant) correlation between the

[49] Note that the partial effects for the participation decision are opposite to the effect of "never been members" status.

Table 20—Determinants of program participation: Parameter estimates and partial changes in probability of participation resulting from marginal changes in selected independent variables

Independent variable	Parameter estimates			Partial changes in the probability of participation ($\partial Prob(j\|x)/\partial x$)			
	β_0	β_1	β_2	MRFC	Second program	Past member	Never been member
Constant term	1.650	1.927	1.007	. . .	. . .	. . .	. . .
	(–3.83)	(1.02)	(4.11)	. . .	. . .	. . .	. . .
MRFC program dummy variable	1.193	. . .	. . .	0.2702	–0.1162	–0.1540	–0.1089
	(20.03)	. . .	. . .	(17.82)	(–13.23)	(–17.31)	(–16.73)
MMF program dummy variable	. . .	1.012	. . .	–0.0906	0.1712	–0.0806	–0.0606
	. . .	(2.90)	. . .	(–4.53)	(3.56)	(–2.79)	(–2.41)
MUSCCO program dummy variable	. . .	0.607	. . .	–0.065	0.108	–0.043	–0.030
	. . .	(6.04)	. . .	(–8.18)	(6.37)	(–4.23)	(–3.96)
PMERW1 program dummy variable	. . .	1.177	. . .	–0.1004	0.1953	–0.0948	–0.0731
	. . .	(21.00)	. . .	(–12.37)	(12.13)	(–9.24)	(–8.40)
PMERW2 program dummy variable	. . .	1.181	. . .	–0.1006	0.1958	–0.0952	–0.0734
	. . .	(21.03)	. . .	(–12.52)	(12.29)	(–9.32)	(–8.49)
Number of years of MRFC operation in the area	–0.004	. . .	. . .	–0.0007	0.0002	0.0005	0.0005
	(–0.14)	. . .	. . .	(–0.15)	(0.14)	(0.15)	(0.15)
Number of years of MUDZI Fund operation in area	. . .	–0.577	. . .	0.0390	–0.0901	0.0512	0.0339
	. . .	(–1.87)	. . .	(1.92)	(–1.88)	(1.85)	(1.86)
Number of years of MUSCCO operation in area	. . .	–0.080	. . .	0.0054	–0.0125	0.0071	0.0047
	. . .	(–1.19)	. . .	(1.21)	(–1.18)	(1.15)	(1.16)
Number of years of PMERW1 operation in area	. . .	–1.255	. . .	0.0848	–0.1961	0.1113	0.0737
	. . .	(–1.13)	. . .	(1.16)	(–1.13)	(1.11)	(1.12)
Number of years of PMERW2 operation in area	. . .	1.092	. . .	–0.0738	0.1707	–0.0969	–0.0641
	. . .	(0.84)	. . .	(–0.86)	(0.84)	(–0.83)	(–0.83)
Transaction cost–adjusted average interest rate of MRFC/SACA	0.748	. . .	. . .	0.1494	–0.0506	–0.0989	–0.0590

	(0.39)	. . .	. . .	(0.40)	(–0.40)	(–0.41)	(–0.40)
Transaction cost–adjusted average interest rate of other program	. . .	–2.375		0.1605	–0.3713	0.2108	0.1395
	. . .	(–0.59)	. . .	(0.60)	(–0.59)	(0.58)	(0.59)
Total hectares of household land	0.011	–0.005	–0.019	0.0026	–0.0016	–0.0010	–0.0066
	(0.80)	(–0.74)	(–1.34)	(0.93)	(–1.11)	(–0.51)	(–1.31)
Share of household cultivated land out of total land owned	0.000	0.001	–0.002	0.0000	0.0001	–0.0001	–0.0007
	(0.28)	(0.93)	(–1.57)	(0.09)	(0.70)	(–0.57)	(–1.55)
Total value of assets owned	0.000	0.000	0.000	0.0000	0.0000	0.0000	0.0000
	(–0.43)	(–0.33)	(–1.77)	(–0.42)	(0.20)	(0.45)	(–1.73)
Share of value of assets held as land	–0.039	0.080	–0.006	–0.0132	0.0151	–0.0019	–0.0020
	(–0.50)	(1.57)	(–0.05)	(–0.88)	(1.75)	(–0.16)	(–0.05)
Share of value of assets in livestock	0.046	0.073	0.198	0.0043	0.0083	–0.0126	0.0654
	(0.35)	(1.03)	(1.11)	(0.17)	(0.63)	(–0.65)	(1.11)
Age of household head	–0.001	0.001	0.000	–0.0002	0.0001	0.0001	–0.0001
	(–0.67)	(0.57)	(–0.14)	(–0.82)	(0.94)	(0.37)	(–0.14)
Male-headed household dummy variable	0.103	–0.015	–0.030	0.0214	–0.0092	–0.0122	–0.0136
	(2.03)	(–0.41)	(–0.47)	(2.15)	(–1.39)	(–1.66)	(–0.91)
Years of schooling of household head	0.010	–0.001	–0.005	0.0020	–0.0008	–0.0012	–0.0015
	(1.16)	(–0.22)	(–0.53)	(1.28)	(–1.04)	(–0.87)	(–0.52)
Years of schooling of spouse	–0.013	0.000	–0.001	–0.0026	0.0009	0.0017	–0.0005
	(–1.23)	(0.04)	(–0.15)	(–1.32)	(0.88)	(0.98)	(–0.15)
Adult population between 15 and 64 years of age	–0.049	0.021	–0.121	–0.0111	0.0065	0.0046	–0.0420
	(–1.96)	(1.31)	(–4.88)	(–2.34)	(2.51)	(1.15)	(–4.55)
Dependency ratio (household size divided by population ages less than 15 or over 64)	–0.059	0.033	–0.485	–0.0141	0.0091	0.0050	–0.1686
	(–0.61)	(0.53)	(–4.19)	(–0.75)	0.93)	(0.32)	(–3.99)
ρ: 0.89 (0.03)							
McFadden's pseudo *R*-squared: 0.57							
Cragg and Uhler's pseudo *R*-squared: 0.28							

Note: *t*-Values are given in parentheses.

longer presence of a program in an area and the marginal probability of participation of households in that program. This can be explained by the fact that in each area programs tend to reach their maximum membership sizes in their early years of operation, with some members dropping out and few new members joining in later years.

We can also note from Table 20 that the transaction cost–adjusted interest rates charged by MRFC and the second program do not have statistically significant effects on the program membership decisions. But this insignificance may be due to a lack of sufficient variation in the two transaction cost–adjusted interest rate series. Three other important variables have statistically significant effects on program membership decisions. Being a male-headed household increases the probability of joining MRFC but decreases the probabilities of joining the second program and of being a past member. This is not surprising because female-headed households are more likely to be landless and therefore would prefer to join credit programs that lend for nonfarm businesses rather than MRFC, which gives only seasonal agricultural loans. In contrast, a higher dependency ratio or a higher adult population size increases the probability of joining the second program and decreases the probability of joining MRFC.

Determinants of Household Access to Formal and Informal Credit

Tables 21 and 22 present the results of the determinants of the extent of household access to formal and informal credit as measured by household credit limits in each market, respectively. The extent of household access to formal and informal credit was significantly higher before October 1994. For formal credit, this result reflects partly the longer recall period for loans before October 1994 and the fact that MRFC only began its lending in October 1994, following the collapse of the previous state-owned agricultural credit program. As for informal credit, the preceding crop year (1992/93) was one with a good harvest, which may have had a positive effect on the availability of informal credit in the 1993/94 season. As the 1993/94 season was a drought year, the drop in the availability of informal credit following the drought, as shown in the descriptive and econometric analysis, is plausible.

As expected, all five credit programs contribute statistically significantly to the access to formal credit of their member households, with differences compared with noncurrent members ranging from as low as MK 9 per capita per season for MMF to as high as MK 155 per capita per season for MRFC. Furthermore, except for MRFC and PMERW1, the number of years of operation of a program in an area is positively correlated with access to credit for both participants and nonparticipants. The negative correlation between the extent of the general population's access to credit and the length of MRFC presence in the village can be explained by two facts:

1. MRFC is considered a continuation of the SACA program that was operating in the survey areas for more than a decade (compared with less than five years for the other programs).

Table 21—Formal credit limit equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^{F}_{max})	Partial effects[a] ($\partial E(b^{F}_{max}\|x)/\partial x$)
Constant term	115.50	56.4
	(1.71)	(1.68)
MRFC program dummy variable	174.70	154.61
	(5.87)	(5.57)
MMF program dummy variable	8.78	9.49
	(0.20)	(0.23)
MUSCCO program dummy variable	68.41	65.49
	(1.52)	(1.55)
PMERW1 program dummy variable	71.16	69.31
	(2.77)	(2.81)
PMERW2 program dummy variable	154.80	149.30
	(3.91)	(3.90)
Past member status dummy variable	–50.16	–24.51
	(–1.98)	(–1.98)
Number of years of MRFC operation in area	–3.75	–1.83
	(–2.24)	(–2.23)
Number of years of MUDZI Fund operation in area	82.08	38.78
	(3.72)	(3.61)
Number of years of MUSCCO operation in area	6.29	2.89
	(0.77)	(0.73)
Number of years of PMERW1 operation in area	–84.98	–44.41
	(–2.70)	(–2.88)
Number of years of PMERW2 operation in area	174.00	87.52
	(3.04)	(3.12)
Number of wholesale buyers coming to village	–40.44	–21.37
	(–3.69)	(–3.95)
1994/95 recall period dummy variable	–16.51	–8.07
	(–3.25)	(–3.31)
Total hectares of household land	13.13	5.06
	(0.90)	(1.44)
Square of total hectares of household land	–0.64	. . .
	(–0.29)	. . .
Share of household cultivated land out of total land owned	1.03	0.51
	(2.89)	(2.90)
Total value of assets owned	0.00	0.00
	(1.01)	. . .
Share of value of assets held as land	–98.54	–47.93
	(–3.43)	(–3.38)
Share of value of assets in livestock	–49.59	–24.12
	(–1.43)	(–1.41)
Years of schooling of household head	–1.25	–0.62
	(–0.49)	(–0.50)
Years of schooling of spouse	6.33	3.11
	(2.85)	(2.83)
Adult population between 15 and 64 years of age	–37.75	–18.35
	(–5.28)	(–5.21)

(continued)

Table 21—*Continued*

Independent variable	Parameter estimates ($\theta^{F_{max}}$)	Partial effects[a] ($\partial E(b^{F_{max}}\|x)/\partial x$)
Dependency ratio (household size divided by population ages less than 15 or over 64)	−206.50	−100.75
	(−5.07)	(−5.05)
Age of household head	−0.67	−0.33
	(−1.53)	(−1.51)
Male-headed household dummy variable	−32.85	7.66
	(−2.34)	(0.30)
Distance from village of parents of head	0.01	0.01
	(0.21)	(0.22)
Southern region dummy variable	−174.30	−85.19
	(−2.53)	(−2.51)

R-squared: 0.29
F-statistic (all coefficients): $F_{(35,1472)} = 8.67$
F-statistic for regressors used as instruments in other equations: $F_{(14,1494)} = 5.48$
F-statistic for formal lender characteristics: $F_{(5,1503)} = 3.21$
Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(7)} = 7178$
Durbin chi-squared statistics for exogeneity: $\chi_{(7)} = 7\ 1240$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(39)} = 23.6$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

2. A large number of past SACA members are barred from obtaining MRFC loans for refusing to repay their SACA group loans.

For PMERW1 the negative correlation can be explained by the fact that the program operates as a revolving fund and is an entry point for its members, who are expected to graduate to the PMERW2 program if they require higher credit limits than they are offered. Hence, if PMERW1 members who graduate to PMERW2 are fewer than those who remain in the program or drop out, and if there are fewer new members in subsequent years, then a negative correlation is likely between access to credit and the number of years of operation of PMERW1 in an area.

Credit program membership is negatively correlated with access to informal credit. This is likely to be a reflection of the self-selective nature of program participation: households who lack access to informal credit are more likely to join credit programs. But an increase in the number of years of operation of MMF, MUSCCO, or PMERW1 in an area significantly increases access to informal credit in that area. This results from the negative correlations between program participation and access to informal credit and between the former and the length of operation of a program in an area, as discussed earlier (Table 20). As shown in Table 22, the characteristics of informal lenders are all significant determinants of access to informal credit except for the proportion of area male-headed households and the area average land-

Table 22—Informal credit limit equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^{I}_{max})	Partial effects[a] ($\partial E(b^{I}_{max}\|x)/\partial x$)
Constant term	217.90	110.07
	(4.28)	(4.24)
MRFC program dummy variable	–21.20	–28.03
	(–2.23)	(–3.16)
MMF program dummy variable	–80.04	–74.93
	(–4.36)	(–4.24)
MUSCCO program dummy variable	–11.90	–9.95
	(–0.77)	(–0.67)
PMERW1 program dummy variable	–71.68	–66.72
	(–6.72)	(–6.54)
PMERW2 program dummy variable	–52.71	–48.26
	(–4.12)	(–3.90)
Past member status dummy variable	29.05	14.67
	(2.64)	(2.65)
Number of years of MRFC operation in area	. . .	0.00
	. . .	(0.04)
Number of years of MUDZI Fund operation in area	. . .	0.65
	. . .	(5.62)
Number of years of MUSCCO operation in area	. . .	0.09
	. . .	(3.76)
Number of years of PMERW1 operation in area	. . .	1.42
	. . .	(3.38)
Number of years of PMERW2 operation in area	. . .	–1.23
	. . .	(–2.41)
Proportion of area heads of households who migrated from another village	–69.69	–35.20
	(–3.58)	(–3.55)
Proportion of area male-headed households	–7.61	–3.84
	(–0.32)	(–0.32)
Area average household adult population size	–50.17	–25.34
	(–3.99)	(–3.96)
Proportion of adult wage laborers in area	–239.20	–120.81
	(–3.88)	(–3.85)
Average years of schooling of adults over 17 years of age	15.77	7.97
	(4.22)	(4.20)
Area average landholding size	24.78	12.51
	(1.94)	(1.91)
Area average value of total household assets	0.08	0.04
	(3.99)	(3.97)
Number of wholesale buyers coming to village	7.18	4.37
	(2.15)	(2.52)
1994/95 recall period dummy variable	–3.35	–1.69
	(–1.96)	(–1.96)
Total hectares of household land	–0.92	1.82
	(–0.14)	(1.29)

(continued)

Table 22—*Continued*

Independent variable	Parameter estimates (θ^{I}_{max})	Partial effects[a] ($\partial E(b^{I}_{max}\|x)/\partial x$)
Square of total hectares of household land	1.08	. . .
	(1.04)	. . .
Share of household cultivated land out of total land owned	–0.19	–0.10
	(–1.39)	(–1.40)
Total value of assets owned	0.00	0.00
	(0.77)	(0.77)
Share of value of assets held as land	–40.94	–20.77
	(–3.84)	(–3.83)
Age of household head	–0.20	–0.10
	(–1.11)	(–1.11)
Male-headed household dummy variable	–14.77	–37.12
	(–2.60)	–3.88)
Share of value of assets in livestock	–58.04	–29.33
	(–4.18)	(–4.18)
Years of schooling of household head	1.15	0.58
	(1.36)	(1.35)
Years of schooling of spouse	0.39	0.20
	(0.42)	(0.42)
Adult population between 15 and 64 years of age	–1.13	–0.63
	(–0.52)	(–0.58)
Dependency ratio (household size divided by population ages less than 15 or over 64)	–26.66	–13.67
	(–2.16)	(–2.18)
Distance from village of parents of head	–0.01	–0.01
	(–0.39)	(–0.42)
Southern region dummy variable	33.37	16.85
	(2.24)	(2.22)

R-squared: 0.05
F-statistic (all coefficients): $F_{(37,1470)} = 4.71$
F-statistic for regressors used as instruments in other equations: $F_{(16,1492)} = 3.19$
F-statistic for formal lender characteristics: $F_{(7,1501)} = 2.72$
Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(7)} = 484$
Durbin chi-squared statistics for exogeneity: $\chi_{(7)} = 2898$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(39)} = 49$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

holding size.[50] But only the average years of schooling of the adult population and the average value of total household assets in an area have positive effects on household access to informal credit. As can be expected, a higher proportion of nonnative heads of households in an area significantly decreases access to informal credit. The area average household adult population size and the proportion of wage laborers in

[50] The area average landholding is, in fact, significant at the 10 percent level.

the area population are also negatively correlated with access to informal credit. These negative correlations imply that the supply of informal loans in an area decreases significantly with the number of people earning—or having the potential to earn—income. This result seems counterintuitive unless most of the adult population does not earn income and wage laborers are found in the poorest segment of the areas' populations.

The landholding size and the total value of assets possessed by a household have no significant effects on access to both formal and informal credit. But the share of cultivable land out of total household land has a positive effect on access to formal credit. This positive effect can be attributed to the fact that the seasonal agricultural loans come as part of input packages corresponding to acreage. The more land a household plants to crops, the higher its credit limit for seasonal crop loans. On the other hand, the marginal effect of the value of land as a share of the total value of household assets is negative and statistically significant for access to both formal and informal credit. The share of livestock out of the total value of household assets also has a negative and statistically significant effect on access to informal credit. Overall these results suggest that the composition of household assets is much more important than their overall value in determining household access to formal credit in Malawi. In particular, except for the case of seasonal crop loans, formal lenders are willing to lend less to households whose assets consist mostly of land and livestock, preferring to lend to households with greater diversification in their asset portfolios and therefore their income sources.

Among the other demographic variables that have statistically significant effects on the extent of access to credit are the number of adults in the household and the dependency ratio, which negatively affect access to formal credit. Since the credit limit as a dependent variable is measured in per capita terms, this result is likely driven by the fact that credit programs usually allow only one member per household. We may also note the number of years of schooling of the spouse, which positively affects access to formal credit; the number of wholesale buyers coming to the village, which positively affects access to informal credit and negatively affects access to formal credit; being a male-headed household, which negatively affects access to informal credit; and living in the southern region of Malawi, which positively affects access to informal credit and negatively affects access to formal credit.

Determinants of Demand for Formal and Informal Credit

The estimation results for the determinants of the demand for formal and informal loans are reported in Tables 23 and 24, respectively. Table 23 shows that when the formal credit constraint is binding the estimated average marginal propensity to borrow out of every additional kwacha of formal credit made available is MK 0.5. When the formal credit constraint is not binding, the estimated average marginal propensity to borrow is negative but not statistically significantly different from zero. Table 24 shows similar results for informal credit with the difference that the estimated

Table 23—Formal credit demand equation: Estimated parameters and direct and indirect partial effects of marginal changes in selected independent variables

		Partial effects[a] ($\partial E(b^F\|x)/\partial x$)				
		When the formal credit constraint is not binding				
Independent variable	Parameter estimates (θ^F)	Directly	Because of the induced change in the formal credit limit	Because of the induced change in the informal credit limit	When the formal credit constraint is binding	Sum of partial effects
Constant term	–6.21	–2.95	. . .	. . .	. . .	–2.95
	(–0.06)	(–0.06)	. . .	. . .	. . .	(–0.06)
Household per capita formal credit limit (MK)	–0.15	–0.06	. . .	. . .	0.50	0.44
	(–0.59)	(–0.62)	. . .	. . .	(34.28)	(4.39)
Squared household per capita formal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .
	(0.31)	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	–0.36	–0.16	. . .	. . .	. . .	–0.16
	(–1.45)	(–1.56)	. . .	. . .	. . .	(–1.56)
Squared household per capita informal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .
	(0.56)	. . .	. . .	. . .	. . .	. . .
MRFC program dummy variable	2.20	–0.32	–5.25	5.05	26.14	25.62
	(0.11)	(–0.03)	(–0.84)	(2.77)	(4.50)	(3.07)
MMF program dummy variable	–55.80	–24.89	–0.66	5.93	5.57	–14.04
	(–1.59)	(–1.57)	(–0.12)	(3.11)	(0.47)	(–0.93)

MUSCCO program dummy variable	–32.82	–14.42	–2.80	0.13	16.95	–0.14
	(–1.11)	(–1.10)	(–1.27)	(0.06)	(2.81)	(–0.01)
PMERW1 program dummy variable	–45.24	–20.16	–3.25	5.27	21.94	3.80
	(–2.01)	(–2.03)	(–0.82)	(3.68)	(3.47)	(0.40)
PMERW2 program dummy variable	–108.10	–48.74	–7.14	3.63	48.17	–4.07
	(–2.61)	(–2.57)	(–1.02)	(2.08)	(3.91)	(–0.25)
Past member status dummy variable	4.26	2.03	1.34	–3.01	–12.14	–11.79
	(0.23)	(0.23)	(0.79)	(–1.65)	(–1.96)	(–1.01)
Transaction cost–adjusted formal interest rate	21.51	10.23	. . .	. . .	. . .	10.23
	(0.72)	(0.72)	. . .	. . .	. . .	(0.72)
Price of maize (MK/kilogram)	11.55	5.53	–0.21	0.02	3.44	8.78
	(1.56)	(1.56)	(–0.98)	(0.22)	(2.56)	(2.20)
1995 tobacco producer price (MK/kilogram)	–1.15	–0.55	–0.07	0.04	1.19	0.61
	(–0.49)	(–0.50)	(–1.00)	(1.27)	(1.70)	(0.45)
1995 tobacco seed price (MK/kilogram)	22.42	10.67	. . .	. . .	. . .	10.67
	(0.98)	(0.96)	. . .	. . .	. . .	(0.96)
1995 chemical fertilizer price (MK/kilogram)	8.97	4.27	. . .	. . .	. . .	4.27
	(1.25)	(1.24)		. . .	. . .	(1.24)
1995 local maize seed price (MK/kilogram)	–0.05	–0.03	. . .	. . .	. . .	–0.03
	(–0.10)	(–0.10)	. . .	. . .	. . .	(–0.10)
1995 hybrid maize seed price (MK/kilogram)	–4.34	–2.07	. . .	. . .	. . .	–2.07
	(–0.95)	(–0.96)	. . .	. . .	. . .	(–0.96)

R-squared: 0.18
F-statistic (all coefficients): $F_{(40,1467)} = 5.46$
F-statistic for regressors used as instruments in other equations: $F_{(11,1497)} = 5.59$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(12)} = 124$
Durbin chi-squared statistics for exogeneity: $\chi_{(12)} = 1042$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(46)} = 38$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 24—Informal credit demand equation: Estimated parameters and direct and indirect partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^I)	Partial effects[a] ($\partial E(b^F\|x)/\partial x$)				
		When the formal credit constraint is not binding				
		Directly	Because of the induced change in the formal credit limit	Because of the induced change in the informal credit limit	When the informal credit constraint is binding	Sum of partial effects
Constant term	–7.77	–9.97	. . .	. . .	. . .	–9.97
	(–0.90)	(–0.90)	. . .	. . .	. . .	(–0.90)
Household per capita formal credit limit (MK)	–0.02	–0.02	. . .	. . .	. . .	–0.02
	(–1.60)	(–1.84)	. . .	. . .	. . .	(–1.84)
Squared household per capita formal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .
	(–0.03)	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	–0.10	–0.15	. . .	. . .	0.49	0.34
	(–1.35)	(–2.10)	. . .	. . .	(30.90)	(4.86)
Squared household per capita informal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .
	(–0.39)	. . .	. . .	. . .	. . .	. . .
MRFC program dummy variable	1.52	1.29	–0.62	2.22	–16.25	–13.35
	(0.74)	(1.40)	(–2.57)	(4.15)	(–6.73)	(–6.12)
MMF program dummy variable	–1.63	–0.99	–0.11	2.15	–15.35	–14.30
	(–0.57)	(–0.74)	(–0.37)	(3.70)	(–5.86)	(–5.15)

MUSCCO program dummy variable	–2.60	–1.31	–0.37	0.01	0.49	–1.19
	(–0.68)	(–0.74)	(–3.63)	(0.01)	(0.11)	(–0.28)
PMERW1 program dummy variable	–3.98	–2.14	–0.46	1.92	–13.46	14.14
	(–1.87)	(–2.12)	(–2.47)	(4.43)	(–4.81)	(–5.48)
PMERW2 program dummy variable	–4.81	–2.53	–1.03	1.33	–8.80	–11.02
	(–1.50)	(–1.68)	(–2.96)	2.69)	(–2.94)	(–3.59)
Past member status dummy variable	–0.94	–1.20	0.41	–4.17	7.13	2.16
	(–0.43)	(–0.42)	(2.39)	(–2.57)	(2.65)	(0.64)
Transaction cost–adjusted formal interest rate	0.30	0.39	. . .	. . .	. . .	0.39
	(0.07)	(0.07)	. . .	. . .	. . .	(0.07)
Price of maize (MK/kilogram)	–0.46	–0.58	–0.22	0.05	–0.14	–0.89
	(–0.52)	(–0.52)	(–3.03)	(0.25)	(–0.30)	(–0.77)
1995 tobacco producer price (MK/kilogram)	–0.01	–0.01	–0.07	0.10	–0.27	–0.25
	(–0.04)	(–0.04)	(–2.33)	(1.30)	. . .	. . .
1995 tobacco seed price (MK/kilogram)	–0.69	–0.88	. . .	. . .	. . .	–0.88
	(–0.58)	(–0.58)	. . .	. . .	. . .	(–0.58)
1995 chemical fertilizer price (MK/kilogram)	0.81	1.04	. . .	. . .	. . .	1.04
	(0.87)	(0.88)	. . .	. . .	. . .	(0.88)
1995 hybrid maize seed price (MK/kilogram)	0.06	0.08	. . .	. . .	. . .	0.08
	(0.16)	(0.16)	. . .	. . .	. . .	(0.16)

R-squared: 0.43
F-statistic (all coefficients): $F_{(39,1468)} = 16.686$
F-statistic for regressors used as instruments in other equations: $F_{(11,1497)} = 1.95$
Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(12)} = 0.03$
Durbin Chi-squared statistics for exogeneity: $\chi_{(12)} = 0.08$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(49)} = 63$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

negative average propensity to borrow when the informal credit constraint is not binding is statistically significantly different from zero. Hence when their credit constraints were binding households would borrow, on average, about half the amount of any increase in their credit limits. But when they were not binding the imperfect information about their credit limits caused decreases in their demands for credit in response to changes in their credit limits, which are significant only for informal credit. The significant decrease in the amount of informal loans demanded in response to increases in the informal credit limit when the informal credit constraint is not binding can be explained as follows. When the informal credit constraint is not binding an increase in the informal credit limit raises its relative value for use in smoothing consumption and thus encourages households to keep more of it available for future, uncertain times in order to be able to better smooth consumption ex post. The average marginal increases in the formal and informal credit demanded across states of both binding and nonbinding credit constraint are MK 0.44 and MK 0.34, respectively. Since these average marginal increases are statistically significantly different from one (and from zero), one of the restrictions implied by the practice of using loan size to measure the impact of access to credit (that is, that households are *always* credit constrained and would borrow the full amount of any increase in their credit lines) is not satisfied (see Chapter 4).

With regard to the substitutability between formal and informal sources of credit, Table 23 shows that the availability of informal credit has a negative but not statistically significant effect on the demand for formal credit. Similarly, as can be seen in Table 24, the availability of formal credit induces a very small and not statistically significant reduction in the demand for informal credit. The insignificant coefficients indicate that the substitutability between formal and informal credit is limited. This is explained by the fact that informal and formal loans differ in many characteristics, such as conditions for loan use, collateral requirements, transaction costs for the borrower, and implicit insurance services expressed by the fact that informal loans mostly do not have a due date. We note that the amounts of informal loans demanded by participants in the credit programs other than MUSCCO are significantly lower than those demanded by nonparticipants. Much of the difference occurs, however, when the informal credit constraint is binding (Table 24). This is not surprising given the finding, mentioned earlier, that program participation is negatively correlated with access to informal credit. In contrast, despite their better access to formal credit, the average amounts of formal loans demanded across the two states of binding and nonbinding credit constraints by participants in the credit programs other than MRFC are not statistically different from those of nonparticipants. This is explained by the fact that the significantly higher amounts of formal credit demanded by participants in those programs when their formal credit constraint is binding correspond to significantly lower amounts of formal credit demanded when their formal credit constraint is not binding (Table 23).

The transaction cost–adjusted interest rate for formal credit has no statistically significant effect on the demand for either formal or informal credit. This lack of statistical significance of the interest rate for formal credit may, however, be due to its

lack of significant variability during the period of time considered and its possible correlation with the program dummy variables.[51] We expect that an increase in output prices for major crops increases the demand for seasonal crop loans, while prices for inputs have an opposite effect. Indeed, increases in the price of maize significantly increase the demand for formal loans. Higher maize prices make maize more profitable compared with other crops and induce households to increase maize production. As the amount of land is largely fixed, production increases can come about only by increasing yields through use of hybrid seed, fertilizer, or both. This in turn increases the demand for seasonal agricultural loans, if households' own resources are insufficient or committed elsewhere in the household economy.[52] The producer price of tobacco has no statistically significant effect, owing to tobacco income's low share of total income for the average household and to the specific regulations in the tobacco market in effect during the survey years. Prior to 1996 tobacco was produced in Malawi under a quota system, and few smallholder farmers in Malawi were allowed to grow it. Therefore, higher tobacco prices would not increase the smallholders' demands for formal loans since their total tobacco production was constrained by quota.[53]

With respect to changes in loan demand due to increases in input prices, we obtain negative and insignificant effects for the prices of seed for hybrid maize and for local maize. The fact that prices for both types of maize seed have no statistically significant effect on credit demand can be explained by seed expenditure's low share of total input costs for maize production. Furthermore, when seed prices increase farmers can substitute recycled seed taken from their own production. This substitution entails less need for cash and therefore less demand for loans. In fact more than 40 percent of the seed used by the sampled households was from their own production (Diagne, Zeller, and Mataya 1996). Such a substitution is not possible for tobacco seed. However, the signs for the price of tobacco seed and of fertilizer have a positive but insignificant effect on loan demand. We explain these unexpected signs as follows. Seasonal agricultural loans almost always come in the form of fixed input packages designed to match the size of the borrower's cultivated area devoted to maize or tobacco. During the two survey years, none of the agricultural credit institutions had adjusted the amount of tobacco seed and fertilizer in the package. As input prices increase, the value of the package and the amount of the loan simply increase. Thus the programs give the farmers little choice in varying their demand for

[51] The majority of borrowers interviewed did not know the actual interest rates they were paying. They knew only the sizes of their loans (in monetary terms or in kind) and the amounts they had repaid or had yet to repay. For this reason we calculated the interest rates for each loan transaction using these two numbers. Dropping the interest rate variable does not make any difference in the estimated coefficients and standard errors for the other variables. We therefore decided to leave it in the equations.

[52] This is consistent with the finding in Zeller, Diagne, and Mataya (1997) that participation in the programs that provide seasonal agricultural loans increases significantly the share of total land allocated to hybrid maize.

[53] The tobacco quota system was lifted in 1996; see Zeller (1998) for more details on the restrictions on tobacco production and marketing prior to 1996.

inputs and loans in response to changes in input prices; rather, it is a choice between taking the loan package or doing without it.[54]

Marginal Impact of Access to Formal Credit on Household Incomes

The estimated marginal impacts of access to formal and informal credit on total household annual income, crop income, and seasonal nonfarm income are reported in Tables 25–27.

For all three types of income and for both formal and informal credit, the direct marginal effects resulting from mere access to formal credit are positive and the indirect marginal effects resulting from exercising the option to borrow are negative. They are both not statistically significantly different from zero, however. The indirect effects resulting from the substitutability between formal and informal sources of credit are also positive but not statistically significantly different from zero. As a result, for the average household, the total marginal impacts of access to formal credit on all three types of income, although positive and quite sizable (MK 0.59, MK 0.53, and MK 0.26, respectively, for every additional kwacha of credit limit), are not statistically significantly different from zero.

The substitution away from informal sources of credit, made possible by access to formal credit, has a positive and statistically significant effect on the annual incomes of participants in credit programs other than MUSCCO. As shown in the tables, this beneficial substitution effect is the result of the negative correlation between borrowing from informal sources and household crop incomes. The negative correlation also applies to formal credit. Therefore it is the mere act of borrowing, whether from informal or from formal sources, that has a negative impact on crop incomes. The beneficial substitution effect of informal credit for formal credit is therefore merely a reflection of the fact that the reduced borrowing from informal sources results in informal loans playing a lesser role in the negative impact that borrowing in general has on net crop incomes.

For the reasons mentioned, substitution away from informal sources of credit by credit program members was beneficial to their crop incomes but detrimental to their nonfarm incomes, with no compensating beneficial effects from the increased reliance on formal loans. Consequently, after controlling for all other factors, the crop incomes of participants in the credit programs are not statistically significantly different from those of nonparticipants. Moreover, the nonfarm incomes of MRFC and MMF members are significantly lower than those of nonparticipants. As a result, the total household incomes of MRFC, MMF, and PMERW1 participants are significantly lower than those of nonparticipants while those of PMERW2 and MUSCCO participants are not statistically significantly different from those of nonparticipants.

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[54] The positive correlation between the price of fertilizer and the demand for formal credit can also be explained by an inelastic demand for fertilizer, as pointed out by a reviewer.

The negative correlation between borrowing and crop income, as is already apparent from the descriptive analysis in Chapter 3, has several causes:

1. A large share of formal loans in 1993/94 and 1994/95 were used in hybrid maize production, and less so in other more profitable crops, in particular tobacco. The in-kind loan package of hybrid maize and fertilizer, as already argued in Chapter 3, was not adequately reduced to take into account the large decline in the ratio of maize prices to fertilizer prices following the devaluation of the Malawi kwacha and the dismantling of fertilizer subsidies. Instead the agricultural credit programs, including MRFC, continued to base the composition of the in-kind loan package on recommendations for hybrid maize production by the agricultural extension service. These recommendations were standardized for the whole country, irrespective of local agroecological and socioeconomic conditions. As Benson (1997) could show with gross margin calculations using on-farm trial data from more than 1,600 sites in Malawi, even in years of relatively favorable climatic conditions, growing maize—the major crop in Malawi—is barely profitable owing to the very low producer price of maize compared with the very high price of fertilizer. Benson's analysis strongly suggests that the recommended fertilizer levels would need to be reduced, and also adapted to specific agroecological regions, in order for maize to be a profitable cash crop for farmers.
2. The two survey years were below-average years for maize as the major crop. While 1993/94 was a severe drought year, the yields in several survey districts were also negatively affected by low rainfall in 1994/95. In years with below-average rainfall, the response of maize yield to fertilizer is less pronounced, making it more economical to apply less. However, farmers do not know in advance whether or not it will rain sufficiently, so the application of fertilizer always runs the risk of creating financial losses in drought-prone areas.
3. Our descriptive and econometric analysis takes into account the full cost of the inputs; that is, it assumes full reimbursement of the principal and interest of the agricultural loan even if the loan package turns out to have created losses because of low rainfall and lack of adjustment in input intensity.[55]

The combination of these three effects explains the finding of the descriptive and econometric analysis that farmers who borrowed for maize production in these two years were worse off than those who did not. We note further that, as shown in the columns for the direct effects, the mere access to credit (formal or informal) is positively correlated with crop income and with nonfarm income. It is the farmers'

[55] That is, the calculated gross margins and net crop income include the cost of the inputs acquired through borrowing even if the loans were not repaid. About 20 percent of the sample households had a negative net crop income for the 1994/95 season. Furthermore, half of the sample households in one of the districts surveyed (Mangochi) experienced a complete crop failure (that is, no harvest).

Table 25—Annual income equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^F)	Partial effects[a] ($\partial E(b^F\|x)/\partial x$)					
			Because of induced change in				
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Sum of partial effects
Constant term	–2,081.00	–1,050.25	. . .	. . .	. . .	. . .	–1,050.25
	(–0.93)	(–0.92)	. . .	. . .	. . .	. . .	(–0.92)
Household per capita formal credit limit (MK)	2.25	0.90	. . .	. . .	–0.40	0.09	0.59
	(0.84)	(1.43)	. . .	. . .	(–1.74)	(1.19)	(1.25)
Squared household per capita formal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.25)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	5.75	2.30	. . .	. . .	0.14	–1.31	1.12
	(1.66)	(1.65)	. . .	. . .	(1.25)	(–1.25)	(0.87)
Squared household per capita informal credit limit (MK)	–0.01	. . .	. . .	. . .	. . .	. . .	. . .
	(–1.44)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	–4.46	–1.80	. . .	. . .	. . .	. . .	–1.80
	(–1.57)	(–2.00)	. . .	. . .	. . .	. . .	(–2.00)
Squared household per capita total formal loans demanded (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .
	(0.68)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	–16.82	–7.64	. . .	. . .	. . .	. . .	–7.64
	(–1.19)	(–1.25)	. . .	. . .	. . .	. . .	(–1.25)
Squared household per capita total informal loans demanded (MK)	0.10	. . .	. . .	. . .	. . .	. . .	. . .
	(0.69)	. . .	. . .	. . .	. . .	. . .	. . .
MRFC program dummy variable	–1,178.00	–813.52	69.14	–86.02	–21.57	86.03	–765.95
	(–2.12)	(–3.03)	(1.29)	(–3.11)	(–0.21)	(2.58)	(–2.66)
MMF program dummy variable	–2,226.00	–929.44	10.92	–93.02	21.25	85.42	–904.87
	(–2.72)	(–2.49)	(0.18)	(–3.09)	(0.27)	(3.03)	(–2.41)
MUSCCO program dummy variable	–187.00	–35.34	39.43	–2.06	–9.56	2.71	–4.82
	(–0.18)	(–0.07)	(2.16)	(–0.06)	(–0.15)	(0.06)	(–0.01)

PMERW1 program dummy variable	−1,758.00	−703.59	48.86	−82.38	−15.60	79.77	−672.93
	(−2.86)	(−2.56)	(1.23)	(−4.22)	(−0.20)	(3.99)	(−2.40)
PMERW2 program dummy variable	−1,387.00	−530.76	112.39	−56.51	−15.12	57.21	−432.80
	(−1.91)	(−1.61)	(1.59)	(−2.34)	(−0.19)	(2.27)	(−1.26)
Past member status dummy variable	1,035.00	522.26	−20.42	53.85	13.56	−32.22	537.04
	(1.95)	(1.94)	(−1.36)	(2.19)	(0.59)	(−1.10)	(2.00)
Tobacco-growing household dummy variable	437.70	220.95	. . .	. . .	−50.52	−18.80	151.63
	(1.43)	(1.42)	. . .	. . .	(−0.92)	(−1.15)	(0.87)
Total hectares of household land	−86.84	107.60	2.29	2.11	−3.91	−1.26	106.83
	(−0.24)	(1.16)	(1.29)	(0.93)	(−1.11)	(−0.27)	(1.14)
Square of total hectares of household land	71.56	. . .	. . .	. . .	. . .	. . .	. . .
	(1.38)	. . .	. . .	. . .	. . .	. . .	. . .
Price of maize (MK/kilogram)	411.70	207.66	3.23	−0.30	−7.97	3.43	206.05
	(1.24)	(1.23)	(2.14)	(−0.22)	(−2.12)	(0.60)	(1.23)
Price of cassava (MK/kilogram)	−235.40	−118.84	−3.87	4.18	5.18	−1.26	−114.61
	(−1.24)	(−1.24)	(−2.59)	(3.36)	(2.40)	(−0.34)	(−1.19)
1995 tobacco producer price (MK/kilogram)	207.70	104.98	1.07	−0.64	−0.55	0.95	105.82
	(3.12)	(3.10)	(1.62)	(−1.32)	(−0.42)	(0.55)	(3.12)
1995 tobacco seed price (MK/kilogram)	539.10	272.13	. . .	. . .	−9.68	3.41	265.85
	(1.66)	(1.66)	. . .	. . .	(−0.78)	(0.41)	(1.68)
1995 chemical fertilizer price (MK/kilogram)	190.30	96.03	. . .	. . .	−3.88	−4.03	88.13
	(0.75)	(0.75)	. . .	. . .	(−1.02)	(−0.56)	(0.69)
1995 local maize seed price (MK/kilogram)	. . .	. . .	. . .	. . .	0.02	. . .	0.02
	. . .	. . .	. . .	. . .	(0.09)	. . .	(0.09)
1995 hybrid maize seed price (MK/kilogram)	8.28	4.18	. . .	. . .	1.88	−0.29	5.76
	(0.10)	(0.10)	. . .	. . .	(0.96)	(−0.13)	(0.14)

R-squared: 0.55
F-statistic (all coefficients): $F_{(35,341)} = 11.17$
F-statistic for regressors used as instruments in other equations: $F_{(10,367)} = 9.12$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(15)} = 2144$
Durbin chi-squared statistics for exogeneity: $\chi_{(15)} = 186337$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(38)} = 87$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 26—Crop income equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^y)	Partial effects[a] ($\partial E(y\|x)/\partial x$)					
			Because of induced change in				
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Sum of partial effects
Constant term	–1,967.00	–993.07	. . .	. . .	. . .	. . .	–993.07
	(–1.20)	(–1.19)	. . .	. . .	. . .	. . .	(–1.19)
Household per capita formal credit limit (MK)	1.80	0.70	. . .	. . .	–0.24	0.07	0.53
	(0.87)	(1.62)	. . .	. . .	(–1.48)	(1.46)	(1.68)
Squared household per capita formal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.26)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	1.75	0.58	. . .	. . .	0.09	–0.96	–0.29
	(0.83)	(0.68)	. . .	. . .	(1.10)	(–1.46)	(–0.33)
Squared household per capita informal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .
	(–1.26)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	–2.82	–1.10	. . .	. . .	. . .	. . .	–1.10
	(–1.24)	(–1.66)	. . .	. . .	. . .	. . .	(–1.66)
Squared household per capita total formal loans demanded (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .
	(0.57)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	–12.71	–5.59	. . .	. . .	. . .	. . .	–5.59
	(–1.48)	(–1.51)	. . .	. . .	. . .	. . .	(–1.51)
Squared household per capita total informal loans demanded (MK)	0.09	. . .	. . .	. . .	. . .	. . .	. . .
	(0.98)	. . .	. . .	. . .	. . .	. . .	. . .
MRFC program dummy variable	–181.10	–202.19	54.89	–23.63	–13.48	52.31	–132.09
	(–0.46)	(–1.12)	(1.32)	(–1.64)	(–0.16)	(2.33)	(–0.69)
MMF program dummy variable	–486.60	–191.20	8.68	–26.43	13.37	57.99	–137.59
	(–1.20)	(–1.04)	(0.20)	(–1.66)	(0.21)	(3.18)	(–0.73)
MUSCCO program dummy variable	671.50	315.94	31.35	–0.62	–5.83	2.06	342.90
	(0.94)	(0.97)	(2.05)	(–0.04)	(–0.12)	(0.08)	(1.05)
PMERW1 program dummy variable	–514.20	–199.53	38.84	–23.32	–9.53	53.93	–139.60

	(–1.41)	(–1.22)	(1.35)	(–2.79)	(–0.15)	(3.82)	(–0.78)
PMERW2 program dummy variable	–531.50	–207.45	89.21	–15.84	–9.20	38.01	–105.26
	(–1.13)	(–0.97)	(1.66)	(–1.39)	(–0.15)	(2.27)	(–0.45)
Past member status dummy variable	251.90	127.15	–16.25	13.68	8.40	–10.61	122.36
	(1.17)	(1.16)	(–1.43)	(1.07)	(0.53)	(–0.57)	(1.11)
Tobacco-growing household dummy variable	648.00	327.07	. . .	. . .	–31.32	–13.27	282.47
	(3.14)	(3.12)	. . .	. . .	(–0.84)	(–1.29)	(2.46)
Total hectares of household land	–57.08	78.60	1.79	0.54	–2.38	–0.93	77.62
	(–0.30)	(1.38)	(1.47)	(0.51)	(–1.14)	(–0.30)	(1.36)
Square of total hectares of household land	50.66	. . .	. . .	. . .	. . .	. . .	. . .
	(1.80)	. . .	. . .	. . .	. . .	. . .	. . .
Price of maize (MK/kilogram)	389.30	196.16	2.53	–0.08	–4.86	2.51	196.26
	(1.61)	(1.60)	(2.33)	(–0.14)	(–2.05)	(0.70)	(1.62)
Price of cassava (MK/kilogram)	–96.78	–48.85	–3.03	1.06	3.16	–0.92	–48.58
	(–0.73)	(–0.72)	(–2.98)	(2.00)	(2.25)	(–0.39)	(–0.73)
1995 tobacco producer price (MK/kilogram)	171.90	86.85	0.84	–0.16	–0.34	0.70	87.89
	(3.51)	(3.49)	(1.82)	(–0.84)	(–0.42)	(0.67)	(3.54)
1995 tobacco seed price (MK/kilogram)	300.30	151.57	. . .	. . .	–5.90	2.50	148.17
	(1.18)	(1.17)	. . .	. . .	(–0.75)	(0.48)	(1.18)
1995 chemical fertilizer price (MK/kilogram)	–102.90	–51.92	. . .	. . .	–2.36	–2.95	–57.23
	(–0.90)	(–0.89)	. . .	. . .	(–0.92)	(–0.59)	(–0.98)
1995 local maize seed price (MK/kilogram)	. . .	. . .	. . .	. . .	0.01	. . .	0.01
	. . .	. . .	. . .	. . .	(0.09)	. . .	(0.09)
1995 hybrid maize seed price (MK/kilogram)	–6.36	–3.21	. . .	. . .	1.14	–0.22	–2.28
	(–0.12)	(–0.12)	. . .	. . .	(0.85)	(–0.14)	(–0.09)
	. . .	(0.12)	(0.32)	(–0.76)	(–1.08)	(0.14)	(0.08)

R-squared: 0.38

F-statistic (all coefficients): $F_{(35,341)} = 6.03$

F-statistic for regressors used as instruments in other equations: $F_{(10,367)} = 5.02$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(15)} = 455$

Durbin chi-squared statistics for exogeneity: $\chi_{(15)} = 9781$

Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(38)} = 80$

Note: *t*-Values are given in parentheses.

[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 27—Nonfarm seasonal income equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^y)	Partial effects[a] ($\partial E(y\|x)/\partial x$)					
			Because of induced change in				
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Sum of partial effects
Constant term	696.7	351.6788	. . .	. . .	. . .	. . .	351.6788
	(2.45)	(2.41)	. . .	. . .	. . .	. . .	(2.41)
Household per capita formal credit limit (MK)	0.7406	0.314	. . .	. . .	–0.0535	0.0001	0.2607
	(1.21)	(1.16)	. . .	. . .	(–0.72)	(0.00)	(1.17)
Squared household per capita formal credit limit (MK)	–0.0006	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.79)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	1.313	0.5992	. . .	. . .	0.019	–0.002	0.6162
	(0.95)	(0.97)	. . .	. . .	(0.55)	(–0.00)	(0.70)
Squared household per capita informal credit limit (MK)	–0.0024	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.50)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	–0.5369	–0.2435	. . .	. . .	. . .	. . .	–0.2435
	(–0.75)	(–0.74)	. . .	. . .	. . .	. . .	(–0.74)
Squared household per capita total formal loans demanded (MK)	0.0005	. . .	. . .	. . .	. . .	. . .	. . .
	(0.44)	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	–0.1916	–0.0118	. . .	. . .	. . .	. . .	–0.0118
	(–0.03)	(–0.00)	. . .	. . .	. . .	. . .	(–0.00)
Squared household per capita total informal loans demanded (MK)	0.0305	. . .	. . .	. . .	. . .	. . .	. . .
	(0.35)	. . .	. . .	. . .	. . .	. . .	. . .
MRFC program dummy variable	–201	–121.117	20.1556	–18.9683	–5.6017	–35.9941	–161.526
	(–2.21)	(–3.01)	(1.48)	(–1.95)	(–0.59)	(–1.27)	(–3.27)
MMF program dummy variable	–346.9	–148.229	3.4049	–19.8515	2.8582	–16.9588	–178.777
	(–2.49)	(–2.30)	(0.21)	(–1.75)	(0.33)	(–0.74)	(–2.53)
MUSCCO program dummy variable	–158.5	–65.3507	12.3723	0.076	– 2.4364	1.8099	–53.529
	(–1.49)	(–1.37)	(1.83)	(0.01)	(–0.48)	(0.06)	(–0.89)

PMERW1 program dummy variable	–79.5	–23.0108	15.1387	–17.4661	–3.3011	–16.0971	–44.7363
	(–0.86)	(–0.55)	(1.20)	(–2.51)	(–0.44)	(–1.08)	(–0.99)
PMERW2 program dummy variable	59.18	41.6651	32.5264	–11.6292	–4.094	–12.2958	46.1725
	(0.51)	(0.79)	(1.64)	(–1.36)	(–0.61)	(–0.65)	(0.85)
Past member status dummy variable	251.7	127.0425	–6.2642	10.7444	2.3892	28.8024	162.7143
	(2.11)	(2.11)	(–1.13)	(0.96)	(0.38)	(1.21)	(2.22)
Tobacco-growing household dummy variable	–97.64	–49.2839	. . .	. . .	–5.9859	10.2774	–44.9925
	(–1.18)	(–1.17)	. . .	. . .	(–0.45)	(0.49)	(–0.83)
Total hectares of household land	–33.59	3.074	0.8024	0.5514	–0.5288	–0.0019	3.8971
	(–0.31)	(0.13)	(0.99)	(0.51)	(–0.57)	(–0.00)	(0.17)
Square of total hectares of household land	9.486	. . .	. . .	. . .	. . .	. . .	. . .
	(0.56)	. . .	. . .	. . .	. . .	. . .	. . .
Price of maize (MK/kilogram)	–39.29	–19.94	1.1331	–0.0779	–1.0793	0.0053	–19.9588
	(–1.29)	(–1.28)	(1.72)	(–0.15)	(–1.26)	(0.00)	(–1.28)
Price of cassava (MK/kilogram)	–63.04	–31.8202	–1.3556	1.0906	0.701	–0.0019	–31.3862
	(–2.99)	(–2.98)	(–2.18)	(2.23)	(1.34)	(–0.00)	(–2.90)
1995 tobacco producer price (MK/kilogram)	. . .	0.038	0.3764	–0.1663	–0.0751	0.0015	0.1746
	. . .	(0.73)	(1.23)	(–0.87)	(–0.23)	(0.00)	(0.24)
1995 tobacco seed price (MK/kilogram)	. . .	. . .	. . .	. . .	–1.3109	0.0053	–1.3057
	. . .	. . .	. . .	. . .	(–0.44)	(0.00)	(–0.27)
1995 chemical fertilizer price (MK/kilogram)	. . .	. . .	. . .	. . .	–0.5245	–0.0062	–0.5307
	. . .	. . .	. . .	. . .	(–0.51)	(–0.00)	(–0.15)
1995 local maize seed price (MK/kilogram)	. . .	. . .	. . .	. . .	0.0032	. . .	0.0032
	. . .	. . .	. . .	. . .	(0.05)	. . .	(0.05)
1995 hybrid maize seed price (MK/kilogram)	. . .	. . .	. . .	. . .	0.254	–0.0005	0.2535
	. . .	. . .	. . .	. . .	(0.37)	(–0.00)	(0.23)

R-squared: 0.10
F-statistic (all coefficients): $F_{(34,1097)} = 4.02$
F-statistic for regressors used as instruments in other equations: $F_{(14,1494)} = 5.5$
Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(15)} = 4$
Durbin chi-squared statistics for exogeneity: $\chi_{(15)} = 25$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(38)} = 88$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

choice to borrow in order to grow fertilizer-intensive hybrid maize that negatively effects their net crop income as a result of the three effects just explained.[56]

Yet, despite the unprofitability of the in-kind input loans for hybrid maize, the findings for the formal loan demand equation suggest that, on average, once they gain access to formal credit, credit-constrained farmers do not restrain themselves from borrowing. This type of behavior on the part of smallholder farmers may seem irrational at first. But Msukwa et al. (1994) offer an explanation for it: that farmers expect debt forgiveness or else intend to default in case of drought and use the unprofitability of maize as an excuse. Although this explanation is plausible for some farmers, it is surely not true for all, as the repayment rates of loans to MRFC ranged between 76 and 95 percent in the two survey years. However, the rate of repayment of maize loans was considerably lower (54 percent) in 1995/96 than that for tobacco loans, which achieved a repayment rate of 82 percent (see Table 1).

A second possible explanation is that current members of credit programs are sufficiently inexperienced with the recommended maize-fertilizer technology that they slavishly follow the cookie cutter advice of the agricultural extension officers. Ex post it turns out that following these recommendations does not pay off, and farmers are left with the choice of repaying, and thus retaining access to future credit, or defaulting. In subsequent years, these new adopters of the recommended maize-fertilizer package would have learned from their experiences and would have begun to apply less fertilizer to hybrid maize. This hypothesis is supported by the finding that past members who had previously had the opportunity to follow the advice of the agricultural extension service under the SACA program applied fertilizer less frequently to their hybrid maize than current members. The percentage of households applying fertilizer to hybrid maize is 71 percent for current members, 35 percent for past members, and 45 percent for households who have never been members (see Table 10). It is interesting that those who have the longest experience with the recommended input package apply it the least. Moreover, past members apply fertilizer almost as frequently to *tobacco* as current members (13 percent and 12 percent for current and past members, respectively; see Table 10).

A third explanation is that the profitability of hybrid maize depends partly on climatic conditions, which can vary greatly from one year to the next. Therefore, the borrowing behavior of smallholder farmers—although seemingly irrational when viewed ex post—can be justified from an ex ante point of view.[57] Furthermore, borrowing may be the best or only option for the smallholder farmers to finance their input acquisitions after experiencing a crop failure. Indeed, the evidence in Chapter 3 suggests that without access to credit the ability of smallholder farmers to recover

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[56] The analysis does not control for differences in land quality. But, as explained in the descriptive section, we believe that differences in the unobserved land quality do not explain the negative impact of borrowing on net crop income.

[57] We thank an anonymous reviewer for reminding us of this important point: the rational calculated risk that borrowers take while trying to maximize their expected returns.

from a crop failure is extremely limited, as shown by the significant drop in their input expenditures (a 50 percent drop, compared with an 18 percent increase for those with access to credit). Moreover, as emphasized in the introduction and Chapter 4, the mere knowledge that credit will be available in case of crop failure (that is, the mere access to credit) can be beneficial to poor farmers living in a risky environment by inducing them to adopt new and more risky but potentially profitable crops or technologies. Indeed, as already discussed, the results of the econometric analysis confirm the positive and quite sizable (though not statistically significant) impact of merely having access to credit.

In conclusion, the empirical evidence and the econometric results, supported by other independent research, point out that the recommended level of fertilizer for hybrid maize, which has been adopted as part of the in-kind loan package, leads to suboptimal results for smallholder incomes. During the years of below-average rainfall (1993/94 and 1994/95), households who relied on this package earned significantly less than households who did not.[58]

Finally, one can see from Table 26 that the most important determinant of household crop income is tobacco. Indeed, a household that grows tobacco earns MK 282 more in crop income compared with one that does not. In addition, the producer price of tobacco has a significantly positive effect on crop income (MK 88 of additional income per capita for every Malawi kwacha increase in the producer price). The price of maize (the major food staple and most important crop in terms of area planted in Malawi) and the size of landholding also have positive and relatively large marginal impacts on crop income (MK 196 and MK 78, respectively). But, with their *t*-statistics at 1.62 and 1.36, respectively, these marginal impacts are statistically not different from zero at the usual 5 percent confidence level.[59] The statistical insignificance of the marginal impact of the price of maize is likely to be the result of adverse climatic conditions during the 1994/95 and 1995/96 seasons, which led to lower yields and thus lower net income, regardless of the price of maize. This suggests that even higher maize prices will fail to increase crop income in Malawi under marginal climatic conditions like those during the 1994/95 and 1995/96 seasons.[60] In addition, because most smallholder farmers in Malawi are net buyers of maize (as illustrated by the 61 percent average maize self-sufficiency rate for 1995 shown in Table 16), an increase in the price of maize will be likely to have a negative impact on the food security of the average smallholder household.

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[58] These results regarding the low profitability of borrowing in order to fertilize hybrid maize were also presented at the workshop organized by Bunda College and IFPRI, held at Bunda in October 1996. At the workshop the management of the MRFC shared its disappointing experience with maize loans during the survey years. Since 1995/96 MRFC has been making an increasing share of its loans for tobacco, a crop that does better in years with low rainfall and has a gross margin per hectare about ten times higher than that for hybrid maize.

[59] In specifications that do not include a dummy variable for tobacco households, the marginal impact of land is statistically significant and is the largest. This indicates that, given the current land allocation, the contribution of additional land to crop income will come mostly through allocating more land to the tobacco crop.

[60] Note that crop income includes the nonmarketed portion of crop production, valued at market prices.

Marginal Impact of Access to Credit on Household Food Security

Tables 28–30 present the results related to the effects of access to formal credit on household food security. Three indicators are used: daily food expenditures per capita (Table 28), daily calorie intake per capita (Table 29), and daily protein intake per capita (Table 30).

Access to formal credit has no statistically significant direct effect on per capita household daily food expenditure (Table 28). The indirect effects (through borrowing and income) are also all negligible and statistically insignificant. The only exception is the direct effect of membership in a credit program (which includes the effect resulting from the induced change in the program participation probability weights), which shows that participants in all the credit programs have significantly lower per capita household daily food expenditures than nonparticipants. However, these lower per capita food expenditures may be reflecting the self-selection of food-insecure households into the programs and the targeting of the programs to those households. Nevertheless, when all the direct and indirect effects of membership in the credit programs are added, the per capita household daily food expenditures of participants are still significantly lower than those of nonparticipants.

Second, regarding the impact of access to formal credit on household food security as measured by daily calorie and protein intakes (Tables 29 and 30), neither the direct nor the indirect effects through borrowing and income are statistically significantly different from zero. As a result, the overall marginal impact of access to formal credit on household food security, although positive, is not statistically significantly different from zero. In fact, after adding all direct and indirect effects of membership in a credit program and controlling for the other factors, participants in all the credit programs are significantly more food insecure than nonparticipants. However, Tables 29 and 30 show that the relative food insecurity of credit program participants is largely due to the direct effects of membership in a credit program, which may reflect to a large extent the effects of the self-selection into the programs of households who are already food insecure as well as the targeting of the programs to such households. Indeed, as shown in the tables, mere access to credit has a positive though not statistically significant impact on the food security of credit program participants. Again, as for income, it is the mere act of borrowing (and not just from formal sources) that is negatively correlated with both calorie and protein intake.

There are two possible explanations for the negative correlation between borrowing and food security as measured by calorie and protein intake. The first results from the negative correlation between borrowing and crop income, which, everything else being equal, should lead to lower calorie intake, especially if the smallholder chooses to repay the loan (as is assumed in our calculations). The second possible explanation is that, if the loan granted is not enough to cover the planned investment, the household may cut down on food consumption in order to make up for the shortfall. However, given the evidence on the negative impact of maize loans on net crop income, given the fact that agricultural loans represent the bulk of total loans from the formal sector, and considering that most of it was lent to finance the

production of a crop that turned out to be largely unprofitable, the first explanation seems to have more merit.

We further note from the results in Tables 29 and 30 that after controlling for all other factors the per capita daily calorie and protein intakes of tobacco and nontobacco households are not statistically different. Hence the significant lower per capita daily calorie intake of tobacco households reported in the descriptive analysis must be due to other attributes that cannot be controlled for in a simple tabular analysis. In fact the results in Tables 29 and 30 confirm the conclusions reached in the descriptive analysis that these other attributes are their relatively larger household and adult population sizes and the difficulties they have in meeting their additional food consumption requirements through market purchases. Indeed, the tables show that the household size and dependency ratio and the prices of maize and cassava have relatively large and statistically significant negative marginal effects on calorie and protein intakes. Furthermore, these effects are mostly the result of the direct effects these variables have on daily calorie and protein intakes. Their indirect effects through the various pathways (access to credit, borrowing, and income) are all either negligible in comparison or not statistically different from zero.

The negative and significant direct impact of maize and cassava prices on calorie and protein intakes is not surprising since the two crops are the most important food staples in Malawi. Together they used to occupy over 80 percent of the country's cultivated land. However, as discussed in Chapter 2, smallholder farmers have in recent years increasingly begun to allocate more land to the high-margin tobacco crop at the expense of maize and cassava. But tobacco is a labor-intensive crop that necessitates a larger than average household size or the hiring of additional labor. Therefore, given the nonseparability of the food consumption and production decisions of agricultural households (Singh, Squire, and Strauss 1986), one should expect the prices of maize and cassava and the household population size and composition to have significant direct effects on calorie and protein intakes in addition to their indirect effects through household income. Furthermore, the fact that the direct impact of the price of maize on calorie intake is negative and significant while its indirect effect through household income is positive but statistically insignificant is consistent with the findings that its marginal impact on household income, while sizable, is not statistically different from zero and that smallholder farmers in Malawi are, on average, net buyers of maize because of their 61 percent average maize self-sufficiency (Tables 26 and 16).

Marginal Impact of Access to Credit on the Nutritional Status of Children

The effects of access to formal credit on the nutritional status of preschoolers as measured by their weight-for-age and height-for-age *Z*-scores are presented in Tables 31 and 32. The weight-for-age *Z*-score is a measure of short-term or acute malnutrition whereas the height-for-age *Z*-score is a measure of chronic malnutrition. The results are broadly in agreement with the ones on food security with the fol-

Table 28—Food expenditure equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^y)	Partial effects[a] ($\partial E(y\|x)/\partial x$)						
			Because of induced change in					
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Household income	Sum of partial effects
Constant term	12.10	6.11	. . .	. . .	. . .	. . .	. . .	6.11
	(6.11)	(5.99)	. . .	. . .	. . .	. . .	. . .	(5.99)
Household per capita formal credit limit (MK)	0.00	0.00	. . .	. . .	0.00	0.00	0.00	0.00
	(0.01)	(–0.04)	. . .	. . .	(–0.56)	(–0.18)	(1.04)	(–0.22)
Squared household per capita formal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.09)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	0.01	0.00	. . .	. . .	0.00	0.00	0.00	0.01
	(1.34)	(1.35)	. . .	. . .	(0.48)	(0.13)	(0.69)	(1.23)
Squared household per capita informal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.68)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	0.00	0.00	. . .	. . .	. . .	. . .	0.00	0.00
	(–0.52)	(–0.55)	. . .	. . .	. . .	. . .	(–1.30)	(–0.63)
Squared household per capita total formal loans demanded (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.19)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	0.00	0.00	. . .	. . .	. . .	. . .	0.00	0.00
	(0.11)	(0.13)	. . .	. . .	. . .	. . .	(–0.90)	(0.10)
Squared household per capita total informal loans demanded (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.15)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total income in the 1994/95 season (MK)	0.00	0.00	. . .	. . .	. . .	. . .	. . .	0.00
	(1.43)	(1.41)	. . .	. . .	. . .	. . .	. . .	(1.41)
MRFC program dummy variable	–2.87	–1.87	0.00	–0.15	–0.02	–0.17	–0.22	–2.44
	(–5.29)	(–7.34)	(–0.06)	(–2.80)	(–0.47)	(–1.33)	(–1.17)	(–7.21)
MMF program dummy variable	–3.21	–1.30	0.00	–0.16	0.01	–0.10	–0.18	–1.73
	(–3.97)	(–3.44)	(–0.00)	(–2.50)	(0.26)	(–0.90)	(–1.04)	(–4.11)

MUSCCO program dummy variable	–2.98	–1.25	0.00	0.00	–0.01	0.01	0.02	–1.24
	(–4.58)	(–4.26)	(–0.07)	(0.01)	(–0.37)	(0.09)	(0.15)	(–3.58)
PMERW1 program dummy variable	–3.10	–1.23	0.00	–0.14	–0.01	–0.09	–0.13	–1.60
	(–5.32)	(–4.53)	(–0.04)	(–3.11)	(–0.38)	(–1.80)	(–0.96)	(–5.09)
PMERW2 program dummy variable	–2.68	–1.03	–0.01	–0.09	–0.02	–0.07	–0.08	–1.30
	(–3.28)	(–2.72)	(–0.07)	(–1.80)	(–0.52)	(–0.86)	(–0.73)	(–3.25)
Past member status dummy variable	2.52	1.27	0.00	0.09	0.01	0.12	0.12	1.61
	(3.21)	(3.22)	(0.03)	(1.38)	(0.30)	(1.36)	(1.35)	(3.73)
Tobacco-growing household dummy variable	–0.22	–0.11	. . .	. . .	–0.02	0.05	0.42	0.34
	(–0.50)	(–0.49)	. . .	. . .	(–0.38)	(0.45)	(1.46)	(0.90)
Adult population between 15 and 64 years of age	–0.81	–0.41	0.00	0.00	0.00	0.00	–0.01	–0.42
	(–4.49)	(–4.29)	(0.10)	(–0.41)	(1.59)	(0.00)	(–1.08)	(–4.36)
Dependency ratio (household size divided by population ages less than 15 or over 64)	–4.53	–2.30	0.00	–0.03	0.04	0.00	–0.03	–2.33
	(–3.67)	(–3.67)	(0.11)	(–1.39)	(1.48)	(–0.06)	(–0.84)	(–3.65)
Price of maize (MK/kilogram)	–0.02	–0.01	0.00	0.00	0.00	0.00	0.02	0.00
	(–0.14)	(–0.14)	(–0.08)	(–0.21)	(–1.13)	(–0.11)	(1.09)	(–0.04)
Price of cassava (MK/kilogram)	0.07	0.04	0.00	0.01	0.00	0.00	–0.01	0.04
	(0.58)	(0.57)	(0.08)	(2.89)	(1.02)	(0.06)	(–0.80)	(0.64)
Price of beans (MK/kilogram)	–0.03	–0.01	0.00	0.00	0.00	0.00	0.00	–0.02
	(–0.56)	(–0.56)	(0.08)	(–3.46)	(1.09)	(0.07)	(0.33)	(–0.58)
Weighted price index of vegetables (MK/kilogram)	0.41	0.21	0.00	–0.01	–0.01	0.00	0.00	0.18
	(2.95)	(2.94)	(–0.11)	(–3.28)	(–1.20)	(–0.26)	(–0.39)	(2.51)
Weighted price index of meat and fish (MK/kilogram)	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.06
	(2.27)	(2.24)	(–0.04)	(–1.39)	(–0.87)	(–0.09)	(0.60)	(2.15)
Weighted price index of drink	–0.04	–0.02	0.00	0.00	0.00	0.00	0.00	–0.03
	(–3.24)	(–3.20)	(–0.03)	(–3.61)	(0.28)	(–0.16)	(–0.86)	(–3.60)

R-squared: 0.04
F-statistic (all coefficients): $F_{(35,1095)} = 5.3$
F-statistic for regressors used as instruments in other equations: $F_{(6,1125)} = 2.08$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(16)} = 6.3$
Durbin chi-squared statistics for exogeneity: $\chi_{(16)} = 59$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(45)} = 863$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 29—Daily calorie intake equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable effects	Parameter estimates (θ^y)	Partial effects[a] ($\partial E(y\|x)/\partial x$)						
			Because of induced change in					
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Income	Sum of partial
Constant term	6,376	3,218	. . .	. . .	. . .	. . .	. . .	3,218
	(8.59)	(8.32)	. . .	. . .	. . .	. . .	. . .	(8.32)
Household per capita formal credit limit (MK)	1.35	0.55	. . .	. . .	–0.27	–0.04	0.01	0.24
	(1.19)	(1.18)	. . .	. . .	(–2.02)	(–0.65)	(0.85)	(0.62)
Squared household per capita formal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.73)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	1.34	0.62	. . .	. . .	0.10	0.60	0.02	1.34
	(0.50)	(0.52)	. . .	. . .	(1.57)	(0.53)	(0.59)	(0.93)
Squared household per capita informal credit limit (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.22)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	–2.73	–1.25	. . .	. . .	. . .	. . .	–0.03	–1.28
	(–2.02)	(–2.12)	. . .	. . .	. . .	. . .	(–1.12)	(–2.17)
Squared household per capita total formal loans demanded (MK)	0.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.83)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	7.12	3.49	. . .	. . .	. . .	. . .	–0.14	3.35
	(0.54)	(0.55)	. . .	. . .	. . .	. . .	(–0.71)	(0.53)
Squared household per capita total informal loans demanded (MK)	–0.04	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.22)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total income in 1994/95 season (MK)	0.07	0.04	. . .	. . .	. . .	. . .	. . .	0.04
	(1.10)	(1.09)	. . .	. . .	. . .	. . .	. . .	(1.09)
MRFC program dummy variable	–1,061.00	–740.26	34.73	–19.79	–29.15	–60.76	–54.25	–869.49
	(–5.61)	(–8.11)	(1.41)	(–1.29)	(–1.50)	(–1.34)	(–0.96)	(–7.48)
MMF program dummy variable	–1,665.00	–693.42	6.02	–20.57	14.65	–55.69	–45.16	–794.17
	(–5.30)	(–4.80)	(0.22)	(–1.07)	(0.67)	(–1.44)	(–0.82)	(–4.92)
MUSCCO program dummy variable	–901.10	–372.78	21.74	0.09	–12.67	3.49	4.14	–355.99
	(–3.19)	(–2.88)	(1.69)	(0.00)	(–0.81)	(0.08)	(0.14)	(–2.51)

PMERW1 program dummy variable	−954.50	−354.82	26.57	−18.11	−17.17	−50.00	−31.08	−444.61
	(−4.42)	(−3.48)	(1.41)	(−1.57)	(−1.14)	(−2.34)	(−0.78)	(−3.79)
PMERW2 program dummy variable	−948.60	−351.84	56.18	−12.08	−21.33	−31.07	−20.59	−380.73
	(−3.20)	(−2.52)	(1.72)	(−0.87)	(−1.28)	(−1.09)	(−0.63)	(−2.40)
Past member status dummy variable	1,190.00	600.90	−11.11	11.38	12.38	18.96	30.66	663.15
	(3.87)	(3.88)	(−1.37)	(0.60)	(0.85)	(0.66)	(1.11)	(4.10)
Tobacco-growing household dummy variable	−89.01	−44.93	. . .	. . .	−31.13	23.20	103.98	51.13
	(−0.56)	(−0.56)	. . .	. . .	(−1.07)	(0.74)	(1.11)	(0.41)
Adult population between 15 and 64 years of age	−340.80	−172.05	−5.06	−0.20	4.52	0.04	−2.41	−175.16
	(−5.21)	(−4.95)	(−2.82)	(−0.20)	(3.30)	(0.01)	(−0.90)	(−4.97)
Dependency ratio (household size divided by population ages less than 15 or over 64)	−1,830.00	−928.74	−27.81	−4.27	46.48	−5.23	−8.32	−927.88
	(−4.14)	(−4.14)	(−3.01)	(−0.71)	(3.86)	(−0.25)	(−0.72)	(−4.07)
Distance from village of parents of head	. . .	−0.01	0.00	0.00	0.00	0.00	0.00	−0.02
	. . .	(−1.23)	(0.16)	(−0.15)	(−0.39)	(−0.20)	(−0.56)	(−0.85)
Price of maize (MK/kilogram)	−142.60	−72.24	1.97	−0.08	−5.55	−1.57	3.82	−73.65
	(−2.62)	(−2.63)	(1.93)	(−0.11)	(−2.41)	(−0.40)	(1.01)	(−2.65)
Price of cassava (MK/kilogram)	−98.23	−49.58	−2.36	1.13	3.60	0.57	−2.12	−48.77
	(−2.64)	(−2.64)	(−2.15)	(1.40)	(2.91)	(0.24)	(−0.64)	(−2.62)
Price of beans (MK/kilogram)	−31.68	−15.99	−0.63	−0.58	1.57	0.65	0.22	−14.76
	(−1.81)	(−1.77)	(−1.84)	(−1.65)	(3.43)	(0.28)	(0.29)	(−1.56)
Weighted price index of vegetables (MK/kilogram)	73.30	37.00	6.00	−1.07	−14.72	−4.44	−0.51	22.25
	(1.41)	(1.40)	(3.03)	(−1.59)	(−3.84)	(−1.01)	(−0.34)	(0.82)
Weighted price index of meat and fish (MK/kg)	18.73	9.45	0.57	−0.25	−1.37	−0.50	0.47	8.37
	(0.87)	(0.87)	(1.16)	(−0.70)	(−2.06)	(−0.33)	(0.54)	(0.76)
Weighted price index of drink	−10.85	−5.48	0.16	−0.14	0.09	−0.42	−0.47	−6.25
	(−2.29)	(−2.26)	(0.80)	(−1.69)	(0.78)	(−0.65)	(−0.71)	(−2.46)

R-squared: 0.01
F-statistic (all coefficients): $F_{(35,1095)} = 4.1$
F-statistic for regressors used as instruments in other equations: $F_{(6,1125)} = 1.98$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(16)} = 25$
Durbin chi-squared statistics for exogeneity: $\chi_{(16)} = 293$
Basmann chi-squared statistics for overidentifying restrictions: $\chi_{(45)} = 1946$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 30—Daily protein intake equation: Estimated parameters and partial effects of marginal changes in selected independent variables

		Partial effects[a] ($\partial E(y\|x)/\partial x$)						
			Because of induced change in					
Independent variable	Parameter estimates (θ^y)	Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Income	Sum of partial effects
Constant term	283	143.169	. . .	. . .	. . .	. . .	. . .	143
	(8.34)	(8.18)	. . .	. . .	. . .	. . .	. . .	(8.18)
Household per capita formal credit limit (MK)	0.034	0.014	. . .	. . .	–0.007	–0.001	0.000	0.006
	(0.61)	(0.61)	. . .	. . .	(–1.11)	(–0.26)	(0.22)	(0.29)
Squared household per capita formal credit limit (MK)	0.000	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.39)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	–0.006	–0.002	. . .	. . .	0.003	0.012	0.000	0.012
	(–0.04)	(–0.04)	. . .	. . .	(0.96)	(0.19)	(0.15)	(0.17)
Squared household per capita informal credit limit (MK)	0.000	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.03)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	–0.072	–0.033	. . .	. . .	. . .	. . .	0.000	–0.033
	(–1.05)	(–1.09)	. . .	. . .	. . .	. . .	(–0.26)	(–1.10)
Squared household per capita total formal loans demanded (MK)	0.000	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.47)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	0.125	0.070	. . .	. . .	. . .	. . .	–0.002	0.068
	(0.17)	(0.20)	. . .	. . .	. . .	. . .	(–0.19)	(0.19)
Squared household per capita total informal loans demanded (MK)	0.002	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.23)	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total income in the 1994/95 season (MK)	0.001	0.000	. . .	. . .	. . .	. . .	. . .	0.000
	(0.25)	(0.24)	. . .	. . .	. . .	. . .	. . .	(0.24)
MRFC program dummy variable	–48.890	–32.572	0.857	0.070	–0.761	–4.850	–0.631	–37.886
	(–4.87)	(–6.85)	(0.76)	(0.09)	(–0.90)	(–2.07)	(–0.21)	(–6.56)
MMF program dummy variable	–84.410	–35.758	0.149	0.077	0.384	–2.833	–0.525	–38.505
	(–4.44)	(–4.05)	(0.12)	(0.08)	(0.43)	(–1.41)	(–0.19)	(–4.19)
MUSCCO program dummy variable	–50.670	–21.352	0.539	0.000	–0.331	0.253	0.048	–20.843
	(–3.93)	(–3.67)	(1.01)	(–0.00)	(–0.55)	(0.11)	(0.04)	(–3.36)

PMERW1 program dummy variable	–45.870	–17.549	0.658	0.068	–0.448	–2.631	–0.361	–20.264
	(–4.03)	(–3.37)	(0.77)	(0.16)	(–0.73)	(–2.45)	(–0.17)	(–3.64)
PMERW2 program dummy variable	–41.620	–15.557	1.388	0.044	–0.556	–1.866	–0.239	–16.786
	(–2.79)	(–2.28)	(0.92)	(0.08)	(–0.83)	(–1.36)	(–0.14)	(–2.39)
Past member status dummy variable	52.280	26.388	–0.276	–0.034	0.323	3.281	0.356	30.039
	(3.55)	(3.57)	(–0.83)	(–0.04)	(0.61)	(1.87)	(0.23)	(3.99)
Tobacco-growing household dummy variable	1.486	0.750	. . .	. . .	–0.812	1.503	1.209	2.650
	(0.19)	(0.19)	. . .	. . .	(–0.75)	(0.60)	(0.24)	(0.39)
Adult population between 15 and 64 years of age	–14.870	–7.531	–0.125	0.001	0.119	0.001	–0.028	–7.564
	(–4.85)	(–4.63)	(–1.65)	(0.02)	(2.76)	(0.00)	(–0.20)	(–4.69)
Dependency ratio (household size divided by population ages less than 15 or over 64)	–84.950	–43.135	–0.688	0.017	1.218	–0.104	–0.097	–42.789
	(–4.04)	(–4.06)	(–1.74)	(0.06)	(2.84)	(–0.09)	(–0.18)	(–4.00)
Distance from village of parents of head	. . .	–0.001	0.000	0.000	0.000	0.000	0.000	–0.001
	. . .	(–1.45)	(0.10)	(0.02)	(–0.32)	(–0.07)	(–0.14)	(–0.69)
Price of maize (MK/kilogram)	–5.556	–2.807	0.049	0.000	–0.145	–0.031	0.044	–2.890
	(–1.93)	(–1.93)	(1.16)	(0.01)	(–2.05)	(–0.15)	(0.24)	(–1.98)
Price of cassava (MK/kilogram)	–3.182	–1.606	–0.058	–0.004	0.094	0.011	–0.025	–1.588
	(–1.39)	(–1.39)	(–1.24)	(–0.15)	(1.91)	(0.09)	(–0.15)	(–1.45)
Price of beans (MK/kilogram)	–1.899	–0.959	–0.016	0.002	0.041	0.013	0.003	–0.915
	(–2.08)	(–2.05)	(–1.08)	(0.15)	(2.12)	(0.11)	(0.08)	(–1.95)
Weighted price index of vegetables (MK/kilogram)	1.471	0.742	0.148	0.004	–0.386	–0.088	–0.006	0.415
	(0.56)	(0.55)	(1.75)	(0.16)	(–2.39)	(–0.39)	(–0.08)	(0.31)
Weighted price index of meat and fish (MK/kilogram)	–0.265	–0.134	0.014	0.001	–0.036	–0.010	0.005	–0.159
	(–0.22)	(–0.22)	(0.68)	(0.08)	(–1.60)	(–0.14)	(0.14)	(–0.26)
Weighted price index of drink	–0.397	–0.201	0.004	0.001	0.003	–0.008	–0.006	–0.207
	(–1.58)	(–1.56)	(0.43)	(0.18)	(0.54)	(–0.23)	(–0.17)	(–1.57)

R-squared: 0.02
F-statistic (all coefficients): $F_{(35,1095)} = 3.9$
F-statistic for the regressors used as instruments in other equations: $F_{(6,1125)} = 1.63$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(16)} = 6.4$
Durbin chi-squared statistics for exogeneity: $\chi_{(16)} = 60$
Basmann chi-squared statistics for the overidentifying restrictions: $\chi_{(45)} = 935$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 31—Weight-for-age *Z*-score equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^y)	Partial effects[a] ($\partial E(y\|x)/\partial x$)								
			Because of induced change in							
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Income	Calorie intake	Protein intake	Sum of partial effects
Constant term	0.2705	0.1381	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.1381
	(0.20)	(0.20)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	(0.20)
Household per capita formal credit limit (MK)	0.0006	0.0003	. . .	. . .	–0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
	(0.29)	(0.36)	. . .	. . .	(–0.23)	(0.26)	(–0.33)	(–0.33)	(–0.33)	(0.31)
Squared household per capita formal credit limit (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.00)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	–0.0011	–0.0005	. . .	. . .	0.0000	–0.0003	0.0000	0.0000	0.0000	–0.0008
	(–0.22)	(–0.22)	. . .	. . .	(0.16)	(–0.19)	(–0.27)	(–0.27)	(–0.27)	(–0.33)
Squared household per capita informal credit limit (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.15)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	–0.0007	–0.0003	. . .	. . .	. . .	. . .	0.0000	0.0000	0.0000	–0.0003
	(–0.22)	(–0.24)	. . .	. . .	. . .	. . .	(0.43)	(0.43)	(0.43)	(–0.19)
Squared household per capita total formal loans demanded (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.05)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	–0.0036	–0.0018	. . .	. . .	. . .	. . .	0.0001	0.0001	0.0001	–0.0016
	(–0.18)	(–0.20)	. . .	. . .	. . .	. . .	(0.32)	(0.32)	(0.32)	(–0.17)
Squared household per capita total informal loans demanded (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.01)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total income in 1994/95 season (MK)	0.0000	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.0000
	(–0.42)	(–0.42)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	(–0.42)
Household per capita daily calorie intake (kilocalories)	0.0000	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.0000
	(–0.02)	(–0.02)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	(–0.02)

Household per capita daily protein intake	–0.0023 (–0.50)	–0.0012 (–0.51)	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	–0.0012 (–0.51)
MRFC program dummy variable	0.4159 (1.34)	0.3574 (2.60)	0.0173 (0.52)	0.0144 (0.49)	–0.0073 (–0.20)	0.0541 (0.79)	0.0368 (0.36)	0.0027 (0.01)	1.7811 (0.44)	2.2565 (0.58)
MMF program dummy variable	0.6352 (1.20)	0.2422 (0.99)	0.0026 (0.06)	0.0152 (0.50)	0.0040 (0.09)	0.0398 (0.69)	0.0283 (0.30)	0.0021 (0.01)	1.3661 (0.39)	1.7003 (0.50)
MUSCCO program dummy variable	1.0570 (2.28)	0.4506 (2.18)	0.0102 (0.66)	–0.0003 (–0.01)	–0.0032 (–0.14)	–0.0031 (–0.06)	–0.0038 (–0.09)	–0.0003 (–0.00)	–0.1836 (–0.11)	0.2666 (0.16)
PMERW1 program dummy variable	0.7338 (1.77)	0.2825 (1.50)	0.0125 (0.43)	0.0132 (0.79)	–0.0042 (–0.13)	0.0363 (1.25)	0.0190 (0.29)	0.0014 (0.01)	0.9178 (0.35)	1.2786 (0.50)
PMERW2 program dummy variable	1.2710 (2.58)	0.5352 (2.43)	0.0290 (0.54)	0.0085 (0.43)	–0.0057 (–0.15)	0.0238 (0.61)	0.0121 (0.22)	0.0009 (0.01)	0.5852 (0.28)	1.1889 (0.59)
Past member status dummy variable	–0.5375 (–1.34)	–0.2745 (–1.34)	–0.0049 (–0.45)	–0.0064 (–0.21)	0.0031 (0.12)	–0.0268 (–0.60)	–0.0199 (–0.40)	–0.0017 (–0.03)	–0.0001 (–0.03)	–0.3311 (–1.54)
Tobacco-growing household dummy variable	0.0751 (0.20)	0.0384 (0.21)	. . . . . .	. . . . . .	–0.0084 (–0.17)	–0.0179 (–0.27)	–0.0676 (–0.42)	–0.0024 (–0.03)	–0.0001 (–0.02)	–0.0581 (–0.23)
Adult population between 15 and 64 years of age	–0.2150 (–1.46)	–0.1100 (–1.48)	–0.0027 (–0.94)	0.0002 (0.11)	0.0013 (0.36)	0.0000 (–0.00)	0.0016 (0.35)	0.0016 (0.35)	0.0016 (0.35)	–0.1066 (–1.45)
Dependency ratio (household size divided by population ages less than 15 or over 64)	0.3098 (0.26)	0.1586 (0.27)	–0.0151 (–1.11)	0.0034 (0.36)	0.0131 (0.47)	0.0028 (0.11)	0.0055 (0.29)	0.0055 (0.29)	0.0055 (0.29)	0.1794 (0.30)
Price of maize (MK/kilogram)	. . . . . .	0.0001 (0.22)	0.0011 (0.63)	0.0001 (0.07)	–0.0016 (–0.34)	0.0008 (0.14)	–0.0025 (–0.36)	–0.0025 (–0.36)	–0.0025 (–0.36)	–0.0071 (–0.30)
Price of cassava (MK/kilogram)	. . . . . .	. . . . . .	–0.0013 (–0.62)	–0.0009 (–0.83)	0.0010 (0.36)	–0.0003 (–0.09)	0.0014 (0.26)	0.0014 (0.26)	0.0014 (0.26)	0.0028 (0.16)

R-squared: 0.05
F-statistic (all coefficients): $F_{(37,580)} = 1.3$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(21)} = 25$
Durbin chi-squared statistics for exogeneity: $\chi_{(21)} = 714$
Basmann chi-squared statistics for the overidentifying restrictions: $\chi_{(48)} = 114$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

Table 32—Height-for-age *Z*-score equation: Estimated parameters and partial effects of marginal changes in selected independent variables

Independent variable	Parameter estimates (θ^y)	Partial effects[a] ($\partial E(y\|x)/\partial x$)								
			Because of induced change in							
		Directly	Formal credit limit	Informal credit limit	Formal loan demanded	Informal loan demanded	Income	Calorie intake	Protein intake	Sum of partial effects
Constant term	–3.1760	–1.6216	. . .	. . .	. . .	. . .	. . .	. . .	. . .	–1.6216
	(–1.24)	(–1.24)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	(–1.24)
Household per capita formal credit limit (MK)	–0.0023	–0.0010	. . .	. . .	0.0002	0.0001	0.0000	0.0000	0.0000	–0.0009
	(–0.68)	(–0.75)	. . .	. . .	(0.42)	(0.31)	(–0.93)	(–0.93)	(–0.93)	(–0.78)
Squared household per capita formal credit limit (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(0.20)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita informal credit limit (MK)	–0.0001	–0.0001	. . .	. . .	–0.0001	–0.0008	–0.0001	–0.0001	–0.0001	–0.0012
	(–0.02)	(–0.03)	. . .	. . .	(–0.31)	(–0.21)	(–0.71)	(–0.71)	(–0.71)	(–0.28)
Squared household per capita informal credit limit (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.02)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total formal loans demanded (MK)	0.0019	0.0009	. . .	. . .	. . .	. . .	0.0001	0.0001	0.0001	0.0013
	(0.40)	(0.42)	. . .	. . .	. . .	. . .	(1.24)	(1.24)	(1.24)	(0.57)
Squared household per capita total formal loans demanded (MK)	0.0000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.16)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total informal loans demanded (MK)	–0.0087	–0.0048	. . .	. . .	. . .	. . .	0.0005	0.0005	0.0005	–0.0032
	(–0.19)	(–0.22)	. . .	. . .	. . .	. . .	(0.84)	(0.84)	(0.84)	(–0.15)
Squared household per capita total informal loans demanded (MK)	–0.0001	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	(–0.12)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Household per capita total income in 1994/95 season (MK)	–0.0003	–0.0001	. . .	. . .	. . .	. . .	. . .	. . .	. . .	–0.0001
	(–1.17)	(–1.19)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	(–1.19)
Household per capita daily calorie intake	0.0001	0.0001	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.0001
	(0.32)	(0.32)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	(0.32)

Household per capita daily protein intake	–0.0033 (–0.42)	–0.0017 (–0.42)	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	–0.0017 (–0.42)
MRFC program dummy variable	1.4010 (2.51)	0.9732 (3.94)	–0.0594 (–1.01)	0.0047 (0.09)	0.0182 (0.33)	0.2758 (2.07)	0.2040 (1.03)	–0.0944 (–0.27)	2.5725 (0.35)	3.8946 (0.55)
MMF program dummy variable	1.8900 (2.13)	0.7625 (1.85)	–0.0096 (–0.14)	0.0038 (0.07)	–0.0105 (–0.22)	0.1673 (1.37)	0.1565 (0.88)	–0.0724 (–0.24)	1.9731 (0.31)	2.9706 (0.48)
MUSCCO program dummy variable	1.4830 (1.77)	0.6101 (1.62)	–0.0365 (–1.51)	–0.0002 (–0.00)	0.0081 (0.34)	–0.0151 (–0.13)	–0.0210 (–0.26)	0.0097 (0.07)	–0.2651 (–0.08)	0.2900 (0.09)
PMERW1 program dummy variable	1.4660 (2.40)	0.5521 (2.00)	–0.0447 (–0.96)	0.0034 (0.12)	0.0105 (0.26)	0.1547 (2.87)	0.1051 (0.81)	–0.0486 (–0.22)	1.3257 (0.29)	2.0582 (0.47)
PMERW2 program dummy variable	2.1620 (2.61)	0.8795 (2.33)	–0.0996 (–1.16)	0.0023 (0.07)	0.0143 (0.31)	0.1082 (1.38)	0.0670 (0.61)	–0.0310 (–0.18)	0.8453 (0.24)	1.7860 (0.51)
Past member status dummy variable	–2.1420 (–3.14)	–1.0937 (–3.18)	0.0179 (1.00)	–0.0035 (–0.07)	–0.0079 (–0.26)	–0.1786 (–1.74)	–0.1103 (–1.14)	0.0587 (0.70)	0.0026 (0.70)	–1.3149 (–3.59)
Tobacco-growing household dummy variable	0.4207 (0.76)	0.2148 (0.77)	. . . . . .	. . . . . .	0.0210 (0.34)	–0.0809 (–0.49)	–0.3742 (–1.22)	0.0857 (0.54)	0.0049 (0.44)	–0.1287 (–0.31)
Adult population between 15 and 64 years of age	–0.4037 (–1.55)	–0.2079 (–1.56)	0.0098 (2.20)	0.0000 (0.01)	–0.0033 (–0.92)	–0.0001 (–0.00)	0.0089 (1.08)	0.0089 (1.08)	0.0089 (1.08)	–0.1749 (–1.30)
Dependency ratio (household size divided by population ages less than 15 or over 64)	–0.7626 (–0.37)	–0.3901 (–0.37)	0.0536 (2.54)	0.0007 (0.05)	–0.0341 (–1.14)	0.0072 (0.11)	0.0307 (0.84)	0.0307 (0.84)	0.0307 (0.84)	–0.2707 (–0.26)
Price of maize (MK/kilogram)	. . . . . .	0.0008 (0.49)	–0.0038 (–1.42)	0.0000 (0.01)	0.0041 (0.89)	0.0022 (0.17)	–0.0141 (–1.08)	–0.0141 (–1.08)	–0.0141 (–1.08)	–0.0390 (–0.92)
Price of cassava (MK/kilogram)	. . . . . .	. . . . . .	0.0046 (1.54)	–0.0002 (–0.10)	–0.0026 (–0.78)	–0.0008 (–0.10)	0.0078 (0.83)	0.0078 (0.83)	0.0078 (0.83)	0.0244 (0.80)

R-squared: 0.03
F-statistic (all coefficients): $F_{(37,580)} = 1.5$

Wu-Hausman chi-squared statistics for exogeneity: $\chi_{(21)} = 286$
Durbin chi-squared statistics for exogeneity: $\chi_{(21)} = 3{,}329$
Basmann chi-squared statistics for the overidentifying restrictions: $\chi_{(48)} = 264$

Note: *t*-Values are given in parentheses.
[a] Including the effects resulting from the induced change in the program participation probability weight.

lowing exceptions: For both measures of malnutrition, the direct and indirect effects of access to formal credit are not statistically significantly different from zero for preschoolers living in the average household. However, in contrast to the food security results, the direct effect of membership in a credit program (which includes the effect resulting from the induced change in the program participation probability weights) is positive (that is, better nutritional outcomes) and statistically significant for all the programs except MMF for acute malnutrition and PMERW1 for chronic malnutrition. This is encouraging, although (as already mentioned) these direct positive effects of program membership on the nutritional status of preschoolers may be a pure reflection of the self-selection into the programs of households with better-nourished preschoolers and the targeting of the programs to those households. The plausibility of the self-selection and targeting of households with better-nourished preschoolers is, however, questionable given the previously discussed finding that credit program member households are significantly more food insecure than nonmember households. In any case, when all the direct and indirect effects of membership in credit programs are added, there appear to be no statistically significant differences in both acute and chronic malnutrition between preschoolers in credit program member households and those in nonmember households.

This insignificant effect of credit access on nutritional status has been confirmed in other studies (Zeller and Sharma 1998). Nutritional status is the outcome not just of income, but of a complex set of factors, such as access to water, sanitation, health and vaccination services, and nutrition education. These services are often offered by public institutions or through collective action at the community level. Short-run increases in income in individual households are not likely to increase the supply of such services. The required investments in these services eventually materialize in the long run when increased incomes (potentially achievable through improved access to credit) lead to greater tax revenue that is subsequently spent on social and health services.

CHAPTER 6

Conclusions and Implications for Policy

This study analyzes the determinants of household access to and participation in informal and formal credit markets in Malawi, also considering the question of whether formal credit services crowd out or substitute for informal services. Much of the analysis is devoted to measuring the effect of access to formal credit on the welfare of rural households in Malawi. Such an analysis is important for policy purposes not only because it can serve as a guide for the allocation of scarce resources to the numerous policy instruments competing for the same funds, but also because it establishes the relative importance of the various socioeconomic factors within or beyond the control of policymakers that determine whether or not households will benefit from access to formal credit. This latter information can guide the design of institutional programs and the choice of financial services to be offered to different target groups. We derive a number of conclusions, beginning with those related to the analysis of credit access and loan demand, and then summarizing those regarding the impact analysis of credit access.

First, the composition of household assets is a more important determinant of household access to formal credit than the total value of household assets or landholding size. In particular, a higher amount of land and livestock as a share of the total value of household assets is negatively correlated with access to formal credit. In other words, formal lenders in Malawi prefer to lend to households with more diversified asset portfolios and therefore more diversified incomes, presumably to increase and stabilize repayment rates. Considering these patterns of access to formal and informal credit, we conclude that poor households whose assets consist mostly of land and livestock but who wish to diversify into nonfarm income-generating activities may be constrained by a lack of capital, as both sectors of the market do not grant them access to credit. They may thus be forced to rely on farming as their sole source of income, and one that can be unreliable because of the frequency of drought in Malawi. Indeed, informal loans are usually too small to help start a viable nonfarm income-generating activity. Such poor households may therefore not have any other choice but to sell some of their agriculture-specific assets if they wish to start nonfarm microenterprises. At present, two of the four credit programs analyzed in

this report, MMF and PMERW, target poor households with small landholdings for off-farm microenterprise loans. However, they operate in only some of the districts of Malawi, and their level of coverage within these districts remains too low to have any sizable impact.

Second, the level of interest rates charged on loans seems not to be an important factor for households in choosing which microfinance institution to participate in. Nonprice attributes of credit institutions and their services—including the types of loans provided and restrictions on their use, and educational and social services provided by the programs—play a larger role. This result suggests that the acceptance of an institution by its clientele, and therefore its prospects for growth and sustainability, are determined by a range of characteristics of its financial products. The level of interest rates is only one of these, and not even an important one for the decision to participate in a particular member-based financial institution.

Third, at their present levels of access to credit, households in Malawi are, on average, credit constrained in both the formal and informal sectors, as illustrated by the fact that, for example, close to half of households participating in formal credit programs still have their credit constraints binding. From the econometric analysis we found that when their credit constraints are binding households would borrow, on average, about half the amount of any increase in their credit limits. However, when they are not binding, the imperfect information about their credit limits causes decreases in their demands for credit in response to changes in their credit limits. The decrease in the amount of loans demanded in response to increases in the credit limit when the credit constraint is not binding is explained by the desire of households to increase their ability to smooth their consumption by further increasing their unused credit lines.

Fourth, formal and informal credit are imperfect substitutes for one another. In particular, formal credit, whenever available, reduces but does not completely eliminate informal borrowing. This suggests that the two forms of credit fulfill different functions in the household's intertemporal transfer of resources. Despite the fact that credit is fungible, informal credit is being used relatively more for consumption smoothing purposes. Formal credit is sought and used mostly to finance agricultural production and investment in nonfarm income-generating activities.

The main findings of the study regarding the impact of access to credit on household welfare outcomes are discussed next. The marginal effects on household farm and nonfarm incomes resulting from mere access to formal credit (without necessarily borrowing) are positive and quite sizable. However, they are not statistically significantly different from zero.

Both the tabular analysis and the econometric analysis show that when households choose to borrow they realize lower net crop incomes than nonborrowers. Although this result is not statistically significant, it nonetheless points out a risk of borrowing: that borrowers can be worse off after repaying the principal and interest. We further find that households with increased access to formal credit choose to borrow less from informal sources; that is, they seem to preserve more of their informal credit lines. The increased exposure to risk due to higher formal borrowing and in-

debtedness seems to induce households to use up less of their informal credit lines, presumably to increase their ability to smooth consumption ex post through increased informal borrowing in future periods.

We identify two main reasons for the negative (albeit insignificant) relationship between borrowing and net crop incomes; both have important implications for financial sector policy in Malawi. The first is the focus of the loan portfolio on one loan product that provides farmers too much costly fertilizer for hybrid maize. Three of the four institutions investigated in this study provided agricultural credit, focusing mainly on an input package for hybrid maize. The second reason is the below-average rainfall in the two survey years and the concentration of the loan portfolio of the formal lenders on maize, a drought-sensitive crop. We now discuss the policy implications of these two reasons.

First, seasonal loans for the growing of crops constitute most of the loans in our sample. Of the total amount of those crop loans, most was lent as an in-kind seed and fertilizer package that was applied mostly to hybrid maize during 1993/94 and 1994/95. Our results demonstrate that households that applied this package realized lower or even negative gross margins during the survey years as compared with non-borrowers. The principal problem is that the loan package continued to follow the officially recommended level of fertilizer application for hybrid maize, despite the massive devaluation of the Malawi kwacha and the dismantling of fertilizer subsidies, which tripled fertilizer prices during 1994 and 1995. The advice of the extension service of the Ministry of Agriculture also seemed to ignore the recommendations of agronomic and socioeconomic research during the early 1990s, which emphasized the need to reduce substantially the recommended levels of fertilizer and to customize them to different agroecological zones. These recommendations were made even before the surge in fertilizer prices during 1994/95. Since MRFC was implicitly the successor to SACA, the former parastatal credit program, it appears that it simply took over SACA's major loan product, possibly encouraged by the ministry to do so. According to the Harvard Institute for International Development (1994b), the ministry had been slow in adapting its fertilizer recommendations for smallholder hybrid maize. Indeed, gross margin calculations using on-farm trial data have shown that, even in relatively favorable climatic conditions, fertilizer use on maize, the major crop grown in about 75 percent of the cultivable land in Malawi, is barely profitable owing to the very low relative price of maize and fertilizer (Benson 1997). In fact, according to Benson (1997:14), "under current prices the use of fertilizer on hybrid maize in Malawi cannot be recommended for virtually all of the country."

Beginning in the 1995/96 season, MRFC responded to the low repayment rates on its maize loans during its the first two years of operation (these two years coincided with the period of this survey). The low repayment rate—in comparison to very high repayment rates for tobacco loans—is another indication of the low profitability of the input loan package for hybrid maize. Since 1994 MRFC has lent a dominant and increasing share of its loans to smallholders for burley tobacco, and loans for maize are given only in areas with favorable growing conditions for that crop. However, our results suggest that the smallholders are diverting a large portion of

their tobacco input packages toward hybrid and local maize. This diversion is motivated by their desire to be food self sufficient, which they may see as the best way to guarantee the food security of their households. This food security strategy seems to be well justified given the direct negative impact of the price of maize on calorie intake, as shown by our econometric analysis.

The input package did not give any decisionmaking flexibility to farmers. The agroecological and socioeconomic conditions that drive the optimal intensity of seed and fertilizer use vary not only between districts but also between communities, between households and their individual members, between plots, and between different years of rainfall. The cookie cutter formulations of how much fertilizer and seed to apply to Malawi's smallholder maize crop seem to have been based on a desire to maximize yields and food security at the national level, with no consideration for their implications for the income or welfare of rural households. The maize input packages provided by MRFC should be adapted in line with recent agronomic and socioeconomic research that calls for a lower-intensity fertilizer package, and one differentiated for different soils and regions. It is also recommended that the MRFC and other programs providing agricultural credit offer borrowers more choices of how to use their loans. The most flexible type of loan in terms of future use is one paid out in cash. However, those farmers facing costly or unreliable access to input markets may prefer to have their desired levels of the various inputs for tobacco, hybrid maize, and other crops delivered to a convenient nearby location. Although a young and growing financial institution is well advised to focus on its core business, rural financial institutions—with their considerable and to some extent unavoidable direct exposure to agriculture—should also pay attention to bottlenecks in input markets that may prevent their clients from making optimal use of their loans.

The second reason for the insignificant impact of credit access on crop income was simply insufficient rainfall. On the plots of the survey households in Mangochi, fertilizer grains could be found in the midst of dried-up maize stalks at the end of the growing season. The recommended response to this covariant risk factor for financial institutions is to diversify their assets and liabilities, that is, their loan portfolios and their sources of funds. It is recommended that financial institutions in Malawi seek to lend for different crops and much more for off-farm enterprises. In years with below-average rainfall, up to half of total household income is derived from off-farm enterprises. The considerable risk of drought in Malawi's rainfed agriculture requires that financial institutions accumulate sufficient reserves to be able to write off or reschedule the loans of drought-affected borrowers. Inadequate provisions for loan losses due to drought are otherwise likely to cause their eventual collapse. To avoid such a scenario, the Government of Malawi might consider special legislation that would require rural financial institutions to build up sufficient reserves for drought-related loan losses. These reserves might be partially supplemented by public funds in ways that would provide sufficient incentives and responsibility for the financial institutions to reduce their exposure to drought risk through changes in their portfolio strategies for assets and liabilities, such as those already suggested.

Consistent with the insignificant results for crop income, we find no significant impact of access to credit on the per capita income, food security, and nutritional status of credit program members. As the credit products of the formal institutions are mostly geared toward income generation—and in particular toward production of fertilized hybrid maize and tobacco—access to the type of credit products offered in Malawi is expected to have mostly indirect effects on consumption and nutrition through its potential effect on income. The rural financial institutions in Malawi covered in this study do not offer financial products—such as consumption credit and precautionary savings options—that could eventually have a direct effect on consumption or on nutritional status. However, for the latter welfare indicator there exist other, possibly more important, factors than the availability of financial resources and income. These factors include access to health and vaccination services, safe water, and proper sanitation.

The fact that access to formal credit has not yet benefited credit program members may also be partly due to the relatively short length of their membership. The average length of membership at the time of the survey was less than three years. However, we believe that the overriding cause of the insignificant effect of credit access on household incomes and welfare is rooted in the two reasons given earlier: the concentration on one unprofitable loan product and the occurrence of drought and below-average rainfall in the first and second survey years.

We further find that the most important determinant of household crop income is tobacco. This finding suggests that farmers, instead of growing maize, may wish to devote more of their scarce resources to tobacco in order to increase their household incomes. That such a shift from maize to tobacco is in fact happening can be seen from the recent and rapid transformation of Malawi's tobacco sector. Whereas in 1991 only 7,500 smallholders grew tobacco, it is estimated that over 100,000 grew the crop in 1996, immediately before the abolition of the tobacco quota system.

However, a notable finding of the study is that households that grow tobacco appear to be more food insecure, with significantly lower per capita daily calorie intake and higher prevalence of both chronic and acute malnutrition than households that do not. The food insecurity and malnutrition of tobacco households may be explained by a combination of larger than average household sizes (because of the labor-intensive nature of tobacco growing) and the high relative cost of buying maize for consumption. Indeed, the results indicate that, despite their higher per capita income, tobacco households have greater difficulties buying from the market enough of the additional maize they need to satisfy their consumption requirements. These difficulties are the result of maize markets that are thin owing to a lack of surplus maize from smallholder farmers and an inadequate transportation infrastructure. The unreliability of the market for maize and its consequence for the food security of tobacco farmers call for urgent reforms in the marketing of maize, including a reconsideration of the export and import restrictions.

Another important finding of the study is the significant and negative direct impact the price of maize has on calorie intake while its indirect effect on the latter through household income is positive but statistically insignificant. This finding is

consistent with two other findings of the study: that the marginal impact of the price of maize on household income, while sizable, is not statistically different from zero and that smallholder farmers in Malawi are, on average, net buyers of maize because of their 61 percent average maize self sufficiency. Therefore, an increase in the price of maize is likely to have a negative impact on the food security of the average smallholder farm household.

The scarcity of cultivable land was also found to be a limiting factor for increasing per capita household incomes in Malawi, except perhaps in the northern region of the country. Therefore policy reforms that emphasize more equitable land distribution, to ease the land constraints facing the smallholder farmers and encourage efficient and sustainable use of the existing cultivable land, should be undertaken. However, one must recognize the possible limitation of land reforms in alleviating the land constraint. Indeed, over 80 percent of the cultivated land in Malawi is already being farmed under the customary tenure system by smallholder households with an average landholding of 1.1 hectares (World Bank 1987).[61] Therefore it is doubtful that any land reform that redistributes estate land to smallholders can alleviate in any significant way the land constraint facing the smallholder, since its scope would be limited to the remaining 20 percent of the currently cultivated land in the hands of estates.

Given the limited scope for land reform and expansion of cultivated areas by taking forestland and bushland under cultivation, policy should put much greater emphasis on improving agricultural productivity on the existing land by investing in agricultural research and extension. The production potential of the promising new semiflint hybrid maize varieties could be better exploited with a more regionally differentiated level and mix of fertilizer, by an increase in applied research and related extension to develop alternatives for resource-poor farmers, and by adopting cost-efficient measures to preserve or increase soil fertility, such as the use of organic fertilizer, contour planting, terracing and agroforestry.

Another way of alleviating the severe land constraint facing smallholder farmers is to encourage diversification away from farming through the creation of off-farm enterprises. As the analysis indicates, microentrepreneurs could benefit from improved access to credit, along with training in business management and marketing. The DRD/IFPRI survey found that 57 percent of the members of microfinance institutions started their microenterprises using their own savings. Yet 41 percent of them cited lack of working capital as the main cause of the failure of their businesses (Mandambwe, Zeller, and Diagne 1996).

A major result of this study is that the contribution of rural microfinance institutions to the income of smallholders can be limited or outright negative if the design

[61] A study by Agrarhydrotechnik International (1998), based on aerial photographs, points out that, while virtually all of the land suitable for cultivation has been used up in the southern region of Malawi, the central region and in particular the northern region have considerable reserves of suitable land. However, the study includes all land, including forests and grassland, some of which must be preserved as watersheds, as sources of fuelwood, and so forth. Moreover, some of the suitable but uncultivated land is situated in remote areas, and use of it would require the migration of farmers to such areas.

of the institutions and their services does not take into account the constraints and demands of their clients. The risk of drought in Malawi, as in much of rainfed Sub-Saharan Africa and other countries, constitutes a considerable challenge for developing sustainable rural financial institutions. In such environments, a strategy geared toward greater diversification of the portfolio of assets and liabilities and related provisions for loan defaults in case of drought, including the building up of reserves for rescheduling loans, are necessary preconditions for rural financial institutions to prosper and be able to offer reliable access to future credit and savings services to their clientele.

From the foregoing discussion we conclude that the necessary complementary resources and economic environment are not yet in place for access to formal credit to realize its full potential benefits for Malawi's rural population. Therefore, considering that the formation of sustainable rural financial institutions is such a difficult task in rural economies that lack irrigation, exhibit insufficient hard and soft infrastructure, and have a poorly educated rural population adversely affected by malnutrition and disease, and considering that the benefits at the household level may not materialize in drought years, we recommend a cautious and gradual strategy for expansion of the rural financial institutions. This strategy would require direct support by the state, through an adequate legal and regulatory framework, of institutional innovations and pilot programs in rural areas that might have the potential to reduce transaction costs in providing savings, credit, and insurance services to the rural clientele.

The adoption of a cautious strategy would also imply that the formation and initial expansion of rural financial institutions should focus on high-potential agricultural areas that allow for lending for the production of a diversified array of cash and food crops as well as offering financial services for off-farm enterprises at low transaction costs. This does not mean that low-potential and drought-prone agricultural areas should be neglected, because credit may be the best or only option for smallholder farmers to finance their input acquisitions after experiencing a crop failure. Indeed, the evidence shows that without access to credit the ability of smallholder farmers to recover from a crop failure is extremely limited. In addition, the mere knowledge that credit will be available in case of crop failure can be beneficial to poor farmers in inducing them to adopt new and more risky but potentially profitable crops or technologies. As already mentioned, the econometric analysis has confirmed the positive and quite sizable (though not statistically significant) impact of merely having access to credit. However, the expansion of microfinance into marginal areas with insufficient markets and other infrastructure should be coupled with a greater emphasis on other growth- and welfare-enhancing investments, such as those in transport, health, and communications infrastructure, and with targeted safety net interventions for the very poor.

In summary, the benefits of access to credit for smallholder farmers depend on a range of agroecological and socioeconomic factors, some of which are time-variant and subject to shocks such as drought. Access to credit is therefore no panacea for poverty alleviation. The full potential of credit access in increasing the welfare of the poor can only be realized if coupled with adequate investments in hard and soft infrastructure as well as investments in human capital.

APPENDIX

Econometric Methodology

From an econometric perspective, the system of equations (1)–(5) to be estimated is a disequilibrium model with few additional complications (see, for example, Maddala 1983). Hence if the sample were drawn randomly the likelihood function of the system and the conditional mean equations could be derived along the same lines as in Maddala (1983). But, in order to estimate consistently the parameters of any of the equations in the system, one must derive the likelihood functions and conditional mean equations under choice-based sampling while taking into account the problems of censored or truncated dependent variables. The likelihood function and conditional mean equations corresponding to the random sample case will be shown to be special cases of the corresponding formula derived while taking into account the choice-based nature of the sample. Hence, instead of doing more or less the same derivations twice, we will proceed to derive directly the more general likelihood function and conditional mean equation under choice-based sampling.

Estimation under the Choice-Based Sampling Scheme

First we note that the participation of a household in the jth program, $j = 1, \ldots, J$ (which coincides with the household being in the jth stratum) implies that the following three conditions are met:

1. The program is available and the household is eligible to join it: $b^j_{\max} > 0$.
2. The household's ex ante demand for the credit provided by the program is not unconditionally zero: $b^{*j} > 0$ in at least one possible state of nature.
3. Participating in the jth program is the household's preferred choice among all the mutually exclusive alternative choices:

$$V_j + \xi_j > V_k + \xi_k \qquad k \neq j;\ k = 1, \ldots, J,$$

where V_j $j = 1, \ldots, J$ is the indirect utility achieved by the household when participating in program j and $\xi = (\xi_1, \ldots, \xi_J)$ is a vector of error terms. The inclusion of the error terms in the third condition involving the indirect utility functions follows the random utility framework of McFadden (1981).

We note that these three conditions imply that

$$b^j = \min(b^j_{\max}, b^*) > 0$$

and

$$b^k = \min(b^k_{\max}, b^{*k}) = 0 \qquad k \neq j: \ k = 1, \ldots, J.$$

It follows that a household's participation in the jth program corresponds to the event $\Delta^j \equiv \{\xi_k < V_j - V_k + \xi_j;\ k \neq j;\ k = 1, \ldots, J\}$ and the amount borrowed by that household from the formal sector of the credit market is given by

$$b^F \equiv \sum_{k=1}^{J} b^k = b^j.$$

To proceed further we must derive the probability density under choice-based sampling of the distribution of $y|x$ for a generic dependent variable y and an independent variable x. We note that x can include variables that are stratum dependent (for example, the program dummies). Although the case treated in the literature on estimation under choice-based sampling is that in which the same dependent variable y is used as the stratifying variable (Cosslett 1981, 1993; Hausman and Wise 1981; Manski and McFadden 1981; Amemiya 1985), the same methods can be used to derive consistent estimators of the population parameters when the endogenous stratifying variable is other than y (in this case the membership status variable).

Let $j = 1, \ldots, J$ index the J alternative choices. Our choice-based sampling scheme for selecting a household with data (y,x) amounts to choosing first a stratum j defined by the corresponding alternative with probability $H(j)$ and then choosing randomly a vector (y,x) within the set of all (y,x) belonging to the households in that stratum. Hence the joint probability density of drawing the triplet (x,y,j) under our choice-based sampling scheme is given by[62]

$$\tilde{p}(y,x,j) = H(j) f(y,x|j)$$

where $f(y,x|j)$ is the conditional probability density of (y,x) given j. But by Bayes's rule we have

$$f(y,x|j) = \frac{p(y,x,j)}{Q(j)} = \frac{f(y|x,j)p(j,x)}{Q(j)},$$

where $p(y,x,j)$ and $p(j,x)$ are the joint probability densities of (x,y,j) and (j,x), respectively; $f(y|x,j)$ is the population conditional probability density of y given (x,j); and $Q(j) \equiv \int p(j|x) f(x) dx$ is the true population probability distribution of alternative j, with $p(j|x)$ being the true conditional probability that program j is chosen given x and $f(x)$ being the true probability density of x. For good statistical reasons (see Cosslett 1993), we should take $H(j) \equiv n_j/n$ and $Q(j) \equiv N_j/N$, with n_j (resp N_j) being

[62] We will use the superscript ~ to indicate probability density and conditional mean under choice-based sampling.

the size of the sample (resp population) stratum defined by program j and n and N being, respectively, the total sample and population sizes. Hence the joint probability density function of (y,x) under choice-based sampling is

$$\tilde{f}(y,x) = \sum_{j=1}^{J} \tilde{p}(y,x,j) = \sum_{j=1}^{J} \frac{H(j)}{Q(j)} f(y \mid x,j) p(j,x).$$

Similarly, the probability density function of x under choice-based sampling is

$$\tilde{f}(x) = \sum_{j=1}^{J} \tilde{p}(x,j) = \sum_{j=1}^{J} H(j) f(x \mid j) = \sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j,x).$$

Hence under choice-based sampling the conditional probability density of $y|x$ is given by

$$\tilde{f}(y \mid x) = \frac{\tilde{f}(y,x)}{\tilde{f}(x)} = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} f(y \mid x,j) p(j,x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j,x)} = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} f(y \mid x,j) p(j \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j \mid x)}.$$

To simplify the above expression further, let Δ_y be the support of f and define $\Delta_y^j \equiv \Delta_y \cap \Delta^j$, $j = 1, \ldots, J$. Thus the Δ_y^j, $j = 1, \ldots, J$ form a partition of Δ_y (since the Δ^j, $j = 1, \ldots, J$ exhaust the set of possibilities). Therefore the conditional density $\tilde{f}(y \mid x)$ can be written as

$$\tilde{f}(y \mid x) = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} f(y \mid x, \Delta_y^j) p(\Delta^j \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta^j \mid x)} \quad \text{if } y \in \Delta_y$$

$$= 0 \quad \text{otherwise.}$$

Or, equivalently, given the partitioning of Δ_y by the Δ_y^j, $j = 1, \ldots, J$,

$$\tilde{f}(y \mid x) = \frac{\frac{H(j)}{Q(j)} \frac{f(y \mid x)}{p(\Delta_y^j \mid x)} p(\Delta^j \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta^j \mid x)} = \frac{\frac{H(j)}{Q(j)} f(y \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta^j \mid x)} \quad \text{if } y \in \Delta_y^j;\ j = 1, \ldots, J$$

$$= 0 \quad \text{otherwise.}$$

It is clear that the preceding expression for $\tilde{f}(y \mid x)$ simplifies to the true population density $f(y \mid x)$ under a random sampling scheme (given the fact that $H(j)$ would be equal to $Q(j)$ in that case and that $\sum_{j=1}^{J} p(\Delta^j \mid x) = 1$.

Now, to account for censored or truncated dependent variables, we further partition Δ_y into three subsets: $\Delta_y \equiv \Delta_{y0} \cup \Delta_{y1} \cup \Delta_{y2}$. This partitioning is general enough to apply to either the censored dependent variable case or the truncated dependent variable case or a combination of both, provided we allow for one of the subsets to be possibly empty. For example, the estimation of the credit limit equations fits the truncated dependent variable case with $\Delta_y \equiv \mathbb{R}$, $\Delta_{y0} \equiv \{b_{\max} < 0\}$, $\Delta_{y1} \equiv \{b_{\max} \geq 0\}$, and $\Delta_{y2} \equiv \varnothing$. The estimation of the loan demand equations fits the case of a truncated and censored dependent variable with $\Delta_y \equiv \mathbb{R}$, $\Delta_{y0} \equiv \{b^* < 0\}$, $\Delta_{y1} \equiv \{0 \leq b^* < b_{\max}\}$, and $\Delta_{y2} \equiv \{b^* \geq b_{\max}\}$. Let $\Delta_{ys}^j \equiv \Delta_{ys} \cap \Delta^j$, $j = 1, \ldots, J$; $s = 0, 1, 2$. Thus $\Delta_y^j \equiv \Delta_{y0}^j \cup \Delta_{y1}^j \cup \Delta_{y2}^j$, $j = 1, \ldots, J$. From above the conditional probability of any event Δ_{ys} under choice-based sampling is given by

$$\tilde{p}(\Delta_{ys} \mid x) = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta_{ys} \mid j,x) p(j \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j \mid x)} = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta_{ys}^j \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta^j \mid x)}.$$

Hence the conditional density of $y \mid x$ under the choice-based sampling scheme and accounting for censored and/or truncated dependent variable is given by[63]

$$\tilde{f}(y \mid x) = \frac{\tilde{f}(y \mid x)}{\tilde{p}(\Delta_{ys} \mid x,)} = \frac{\frac{H(j)}{Q(j)} f(y \mid x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(\Delta_{ys}^j \mid x)} \quad \text{if } y \in \Delta_{ys}^j;\ j=1, \ldots, J; \quad s = 1, 2.$$

$$= 0 \quad \text{otherwise}$$

Again, under a random sampling scheme the above expression for $\tilde{f}(y \mid x)$ simplifies to the usual conditional probability density of $y|x$ with a truncated and/or censored dependent variable. Indeed, in that case $H(j) = Q(j)$ and $\sum_{j=1}^{J} p(\Delta_{ys}^j \mid x) = p(\Delta_{ys} \mid x)$, since the Δ_{ys}^j, $j = 1, \ldots, J$ form a partition of Δ_{ys} for $s = 1, 2$.

To write the log likelihood function for a sample of n households, we define the following nJ dummy indicators:

$$d_{ij}^s = 1 \quad \text{if } y_i \in \Delta_{ys}^j; \quad i = 1, \ldots, n; j = 1, \ldots, J; s = 1,2.$$

$$= 0 \quad \text{otherwise}$$

[63] Note that $p(\Delta_{ys}^j \mid x) = p(\Delta_{ys} \mid x)$.

The likelihood and log likelihood functions of the sample under the choice-based sampling scheme are then given, respectively, by[64]

$$L(\theta_1,\theta_2,\theta_3) = \prod_{s=1}^{2}\prod_{i=1}^{n} \frac{\frac{H(j_i)}{Q(j_i \mid \theta_1)} f(y_i \mid x_i;\theta_2)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j \mid \theta_1)} p(d_{ij}^s = 1 \mid x_i;\theta_3)}$$

and

$$L(\theta_1,\theta_2,\theta_3) = 2\sum_{i=1}^{n} \log\left(\frac{H(j_i)}{Q(j_i \mid \theta_1)} f(y_i \mid x_i;\theta_2)\right) - \sum_{s=1}^{2}\sum_{i=1}^{n} \log\left(\sum_{j=1}^{J} \frac{H(j)}{Q(j \mid \theta_1)} p(d_{ij}^s = 1 \mid x_i;\theta_3)\right)$$

Where j_i is the alternative chosen by household i, and θ_1, θ_2, and θ_3 are the vectors of parameters that need to be estimated and $Q(j \mid \theta_1) = \int p(j \mid x;\theta_1) f(x) dx$.[65] The foregoing likelihood function is essentially the same as the one for the Manski-McFadden choice-based sampling estimator, except that here we have the conditional density instead of the conditional probability choice and that we have additional terms to account for the possible truncation or censoring of the dependent variable y_i.[66]

Two types of complications arise when estimating θ_1, θ_2, and θ_3 by maximum likelihood methods. The first type of complication is related to the choice-based sampling scheme that requires some adjustments in the maximum likelihood estimation (MLE) for consistent estimation. The nature of these adjustments depends on whether or not all the $Q(j|\theta_1)$, $j = 1, \ldots, J$ are known, and they are somewhat complicated when one is looking for an efficient estimator (Cosslett 1981, 1993). With unknown population shares $Q(j|\theta_1) \equiv N_j/N$, the MLE estimation is complicated by the impossibility of factoring out the density $f(x)$ that appears in the likelihood function (as would be the case in either a random or an exogenously stratified sample). It turns out that $f(x)$ must be estimated along with the parameters of the model for consistency of parameter estimates. If all the population shares are known, or if they can be consistently estimated from a separate sample (as in our case), then the consistent and efficient estimator is found by maximizing the foregoing log likelihood function under the constraint $N_j/N = \int p(j \mid x;\theta_1) f(x) dx$, which also requires estimat-

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[64] Note that in a truncated dependent variable estimation (as in the case of the credit limit equations), the product over s will have one term only (that is, $s \in \{1\}$).

[65] It is evident from the foregoing that there are parameters that are common to all three parameter vectors.

[66] The Manski-McFadden estimator was originally derived for the discrete model, which aims to estimate the population parameters of the conditional probability choices $p(j \mid x,\theta)$ (Manski and MacFadden 1981; Amemiya 1985:330; Cosslett 1993).

ing the density $f(x)$ appearing in the constraint. Maximizing the log likelihood without the constraint yields the Manski-McFadden estimator, which is much simpler to compute because it does not require estimation of the density $f(x)$.[67] The Manski-McFadden estimator, also called the *conditional MLE estimator* (CML), is consistent, but it is not efficient.

Still, when the population shares are known, a simple modification of the log likelihood that would obtain under a random sampling scheme yields another consistent but not efficient estimator: the Manski-Lerma *weighed exogenous sample maximum likelihood* estimator (WESML). This is the estimator used by Pitt and Khandker (1998). The modification consists of weighting each contribution to the log likelihood that would obtain if the sample were random by the corresponding inverse ratio $Q(j_i)/H(j_i)$. More precisely the Manski-Lerma WESML estimator is obtained by maximizing the following pseudo–log likelihood function:

$$L(\theta_2,\theta_3) = \sum_{s=1}^{2}\sum_{i=1}^{n}\frac{Q(j_i)}{H(j_i)}\left\{\log(f(y_i \mid x_i;\theta_2)) - \log(p(d_{ij}^s = 1 \mid x_i;\theta_3))\right\}.$$

Cosslett (1993) gives a modified score interpretation of the CML and WESML estimators and shows how they respectively reestablish the consistency of the MLE procedure through simple modifications of the score function obtained under a random sampling scheme. Although the relative efficiencies of the two estimators depend on sample design, the WESML estimator tends to have low efficiency when some of the strata are defined by alternatives that are rare in the population (Cosslett 1993).[68]

Since all the population shares are known in our case (they are obtained from the village census carried out prior to the survey), it is in principle possible to use either the Manski-McFadden CML estimator or the Manski-Lerma WESML estimator to estimate θ_2 and θ_3 consistently. Unfortunately we cannot use either estimator directly in our case because of a second complication, due to the multidimensional integral involved in the evaluation of $p(d_{ij}^s = 1 \mid x_i;\theta_3)$. Indeed, it is clear from the foregoing that unless very restrictive distributional assumptions are made, the calculation of $p(d_{ij}^s = 1 \mid x_i;\theta_3)$ would involve evaluating a multidimensional integral of order at least 4. The computational difficulty of such a problem is well known. In fact, until recently, when J was greater than 3 the problem was considered computationally intractable for most probability distributions—including the multivariate normal distribution. However, recently developed simulation methods for calculating multi-

[67] Note also that the θ_1 vector of parameters in the probability choices $p(j \mid x;\theta_1)$ is a subvector of θ_3 and need not be estimated separately.

[68] The reason for this low relative efficiency is that the weighting scheme used by the WESML estimator to achieve consistency assigns low weights to the rarely chosen alternatives; this dilutes the additional information gained by purposely oversampling the latter.

dimensional integrals have considerably reduced the computational difficulty of the problem (McFadden 1989; Pakes and Pollard 1989; Gourieroux and Monfort 1993; Hajivassiliou 1993; Keane 1994; Hajivassiliou, McFadden, and Ruud 1996). The problem is nevertheless a difficult one, despite these advances.

Our estimation problem is further complicated by the fact that we are dealing with a simultaneous equation system consisting of 11 equations. Therefore, even if we rely on the recent simulation-based methods, it is doubtful that we can overcome the computational difficulties involved in estimating the system (as whole or equation by equation) using MLE with numerical integration. Because of these difficulties, we use a two-step estimation method similar to Heckman's two-step procedure to estimate the system equation by equation. The first step consists of estimating the probability choices $p(j_i|x_i;\theta_1)$. This estimation is done only once because $p(j_i|x_i;\theta_1)$ is common to all equations in the system, which is not the case for $p(d_{ij}^s=1|x_i;\theta_3)$. The different functions of $p(d_{ij}^s=1|x_i;\theta_3)$ appearing in relevant equations in the second step of the procedure are estimated in a simple way using the consistently estimated $p(j_i|x_i;\theta_1)$ and the sample analogues of $p(\Delta_{ys}|j)$. These sample analogues are consistent estimates of their population counterparts because of the random sampling within each stratum.

Two-Step Estimation of the Model

The equations in the second step of our two-step procedure are obtained by deriving the population conditional means of the regression $y_i = g_s(x_i,z(j_i);\alpha) + \nu_i$ if $y_i \in \Delta_{yis}$; $s = 1, 2$; $i = 1, \ldots, n$, where g_s is a (possibly nonlinear) scalar valued function, x_i is the vector of regressors that are not specific to any alternative, $z(j_i)$ is the vector of alternative-specific regressors, α is the vector of parameters of interest to be estimated, and ν is the error term. In our particular case, the alternative-specific regressors in the equations are composed of only the credit program dummy variables. In other words, we have $z(j_i) \equiv (D_1(j_i), \ldots, D_{J-1}(j_i))$ with $D_k(j_i) = 1$ if $j_i = k$ and $D_k(j_i) = 0$ otherwise; $k = 1, \ldots, J-1$. The conditional means under choice-based sampling, including all observations, are

$$\tilde{E}(y_i|x_i,z(j_i)) = \int_{\Delta_{y_i}} y_i \tilde{f}(y_i|x_i,z(j_i))dy_i = \sum^{2} w_{j_i s}(x_i,z(j_i);\theta_3) \int_{\Delta_{y_i s}^{j_i}} y_i \frac{f(y_i|x_i,z(j_i);\theta_2)}{p(d_{ij}^s=1|x_i,z(j_i);\theta_3)}\, dy_i,$$

where

$$w_{j_i s}(x_i,z(j_i);\theta_3) = \frac{\frac{H(j_i)}{Q(j_i)}\, p(d_{ij}^s=1|x_i,z(j_i);\theta_3)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)}\, p(d_{ij}^s=1|x_i,z(j);\theta_3)} = \frac{\frac{H(j_i)}{Q(j_i)}\, p(\Delta_{y_i s}|j_i,x_i,z(j_i))p(j|x_i,z(j_i);\theta_1)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)}\, p(\Delta_{y_i s}|j,x_i,z(j))p(j|x_i,z(j);\theta_1)}.$$

Hence

$$\tilde{E}(y_i \mid x_i, z(j_i)) = \sum_{s=1}^{2} w_{j_i s}(x_i, z(j_i); \theta_3) \{g_s(x_i, z(j_i); \alpha) + E(v_i \mid x_i, z(j_i), \Delta^{j_i}_{y_i s})\} \quad i = 1, \ldots, n.$$

If we integrate the multidimensional integrals involved in the probabilities $p(j \mid x_i, z(j); \theta_1)$ and $p(d^s_{ij}=1 \mid x_i, z(j); \theta_3)$ and in the conditional mean $E(\nu_i, \mid x_i, z(j_i), \Delta^{fi}_{y_i s})$, then we can express them as functions of the indirect utility differences,

$$V_j - V_k \equiv \mu_j(x_i, z(j); \beta_j) - \mu_k(x_i, z(k); \beta_k), \quad k \neq j, k = 1, \ldots, J,$$

where μ_j is a (possibly nonlinear) real-valued function and $\beta \equiv (\beta_1, \ldots, \beta_J)'$ is the vector of indirect utility parameters to be estimated.[69] Indeed, let A_j be the $(J-1) \times J$ matrix with ones in the diagonal, minus ones in its jth column, and zero everywhere else. Thus for each j, the $(J-1)$ dimensional vector of indirect utility differences equals $A_j V$; $V \equiv (V_1, \ldots, V_J)'$. With that transformation it can be shown that (see, for example, Börsch-Supan and Hajivassiliou 1993)

$$p(j \mid x_i, z(j); \theta_1) = F_j(A_j \mu(x_i, z; \beta); \theta_F),$$

$$p(d^s_{ij} = 1 \mid x_i, z(j); \theta_3) = F_{vj}(h_s(x_i, z(j); \alpha), A_j \mu(x_i, z; \beta); \theta_{vF}),$$

and

$$E(v_i \mid x_i, z(j_i), \Delta^{j_i}_{y_i s}) = \lambda j_i(h_s(x_i, z(j_i); \alpha), A_{j_i} \mu(x_i, z; \beta); \theta_3),$$

where $\theta_1 \equiv (\beta, \theta_F)'$; $\theta_3 \equiv (\alpha, \beta, \theta_{vF})'$; $\mu(x_i, z; \beta) \equiv (\mu_1(x_i, z(1); \beta_1), \ldots, \mu_J(x_i, z(J); \beta_J))'$; F_j and F_{vj} are the marginal distribution functions of the random vectors $A_j \xi$ and (ν, ξ), respectively; λ_{j_i} is a nonlinear function of its arguments, and h_s is a scalar-valued (possibly nonlinear) function.[70] Hence the conditional means equations that must be estimated in our two-step procedure are given by

$$\tilde{E}(y_i \mid x_i, z(j_i)) = \sum_{s=1}^{2} w_{j_i s}(x_i, z(j_i); \theta_3) \{g_s(x_i, z(j_i); \alpha) + \lambda_{j_i}(h_s(x_i, z(j_i); \alpha), A_{j_i} \mu(x_i, z; \beta); \theta_3)\}.$$

The expressions of $\lambda_j(.)$ can be derived if (ν, ξ) is distributed multivariate normal (Tallis 1961; Johnson and Kotz 1972; Amemiya 1974, 1985; Duncan 1980). In particular $\lambda_j(.)$ reduces to the inverse of Mill's ratio if (ν, ξ) has the bivariate normal distribution. McFadden (1978) also derived the general expression $\lambda_j(.)$ in the case in which (ν, ξ) has the generalized extreme value distribution. In general $\lambda_j(.)$ is a

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[69] For identification purposes, we must set one of the μ_j to zero (say, we set $\mu_j \equiv 0$).

[70] In most cases h_s is equal to g_s or is a simple linear transformation of g_s.

J-dimensional integral with its calculation requiring the same numerical integration procedure as for the calculation of the probabilities $p(j \mid x_i,z(j);\theta_1)$ and $p(d_{ij}^s = 1 \mid x_i,z(j);\theta_3)$. To avoid the difficult numerical integration problem, we do two things: First we combine the (possibly nonlinear) *unknown* function $g_s(.;\alpha)$ and the *unknown* nonlinear function $\lambda_{j_i}(h_s(.;\alpha),A_{j_i}\mu(.;\beta);\theta_3)$ into one *unknown* nonlinear function $G_{j_is}(.;\theta_3)$, which we will approximate by a *known* functional form that can be computed without numerical integration.[71] In other words we write

$$G_{j_is}(x_i,z(j_i);\theta_3) \equiv g_s(x_i,z(j_i);\alpha) + \lambda j_i(h_s(x_i,z(j_i);\alpha),A_{j_i}\mu(x_i,z;\beta);\theta_3).$$

The standard methodology consists of postulating first a linear function for g_s and μ and then dealing with the censoring problem by postulating a probability distribution function for the error term (ν,ξ) to arrive at a nonlinear regression function to be estimated. Our alternative method of specifying the nonlinear regression function to be estimated has been motivated by our desire to circumvent the numerical integration problem. But Deaton (1990) justifies the method on the ground that it is the conditional mean regression that is identified from the data and that it is impossible to disentangle the censoring problem from the unknown functional form problem without using arbitrary and untestable identifying assumptions.

The second thing we do to circumvent the numerical integration problem is to approximate the $w_{j_is}(x_i,z(j_i);\theta_3)$ probability weights by another set of probability weights defined by

$$w_{j_is}(x_i,z(j_i);\theta_1) \equiv \frac{\frac{H(j_i)}{Q(j_i)}\, p(\Delta_{y_is} \mid j_i)p(j \mid x_i,z(j_i);\theta_1)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)}\, p(\Delta_{y_is} \mid j)p(j \mid x_i,z(j);\theta_1)}.$$

The weights $w_{j_is}(x_i,z(j_i);\theta_1)$ are approximations of $w_{j_is}(x_i,z(j_i);\theta_3$ because we are replacing the probability $p(\Delta_{y_is} \mid j,x_i,z(j))$ (which is conditional on j and $(x_i,z(j))$ with the marginal probability $p(\Delta_{y_is} \mid j)$ (which is conditional on only j). However, the equality of the two probabilities is not a necessary condition for the approximation to be exact. For example, if $p(d_{ij}^s = 1 \mid x_i,z(j);\theta_3) = p(\Delta_{y_is} \mid x_i)p(\Delta_{y_is} \mid j)p(j \mid x_i,z(j);\theta_1)$, then we would have $w_{j_is}(x_i,z(j_i);\theta_1) = w_{j_is}(x_i,z(j_i;\theta_3)$.[72] There are two computational advantages for using $w_{j_is}(x_i,z(j_i);\theta_1)$ instead of $w_{j_is}(x_i,z(j_i);\theta_3)$:

1. Since the households were randomly selected within each stratum, for each j and each s, the sample share of the y_i that are in Δ_{y_is} is a consistent estimate of the corresponding population conditional probability $p(\Delta_{y_is} \mid j)$. For the

[71] Note that we know from the foregoing derivations that the parameter vectors α and β are part of θ_3.

[72] Note that the approximation issue is relevant only for the equations with limited dependent variables. Indeed, in the equation in which the dependent variables are not limited we always have $s \in \{1\}$, $\Delta_{y_is} = \Delta_{y_i}$ and $p(\Delta_{y_i} \mid j,x_i,z(j)) = p(\Delta_{y_i} \mid j) = 1$.

formal and informal credit limit equations, these sample shares are the proportions of households in a given stratum with and without access to credit, respectively, as defined previously. For the loan demand equations, the shares are the proportions of households in a given stratum with and without a binding credit constraint, respectively.

2. With these shares as consistent estimates of the $p(\Delta_{y_{is}} | j)$, the first-stage estimation of the probability weights $w_{j_{is}}(x_i, z(j_i); \theta_1)$ is now reduced to estimation of the probability choices $p(j | x_i, z(j); \theta_1)$, which are common to all equations in the system. This estimation still requires the computation of a multidimensional integral of order 3 since we have four alternative choices. But the problem is more manageable than performing the same type of difficult MLE estimation for at least five equations, with four of them involving a multidimensional integral of order 4. Furthermore, by adopting the nested multinomial logit model for this first-stage estimation, we can avoid entirely the problem of computation of the multidimensional integral. The first-stage estimation is described in the next section. In the remainder of this section we focus on the estimation of the system of simultaneous equations in the second step of our two-step procedure.

Second Step of the Estimation Procedure: Estimation of the System

Because of an already large set of regressors, in all the equations we use a quadratic (in the variables) approximation for the $G_{j_{is}}$ functions with limited squared and interaction terms for only the most important variables.[73] A more flexible functional form usually causes high-dimensionality problems, which we want to avoid. We begin with the credit limit equations.

The Credit Limit Equations

As explained previously, we have a truncated dependent variable with truncation point at zero. That is, $\Delta_y \equiv \mathbb{R}$, $\Delta_{y0} \equiv \{b_{\max} < 0\}$, $\Delta_{y1} \equiv \{b_{\max} \geq 0\}$, and $\Delta_{y2} \equiv \varnothing$. Hence $s \in \{1\}$ and

$$\tilde{E}(b_i^{K\max} | x_{1i}, z_{1v_i}^K, z(j_i)) = \hat{w}^{K\max} G_{j_i 1}^{K\max}(x_{1i}, z_{1v_i}^K, z(j_i); \theta_3^{K\max})$$

$$K \in \{F, I\} \equiv \{\text{formal, informal}\} \quad \text{and} \quad i = 1, \ldots, n. \qquad ;$$

[73] In other words, the $G_{j_{is}}(.;\theta_3)$ functions are linear in the parameters with squared and cross-product terms for a limited number of variables.

$$\hat{w}_{j_i a}^{K} \equiv w_{j_i a}^{K}(x_i, r^F, z_i, z(j_i); \hat{\theta}_1) \equiv \frac{\dfrac{H(j_i)}{Q(j_i)} \dfrac{n_{j_i a}^{K}}{n_{j_i}} p(j_i \mid x_i, r^F, z_i, z(ji)); \hat{\theta}_1)}{\displaystyle\sum_{j=1}^{J} \frac{H(j)}{Q(j)} \frac{n_{ja}^{K}}{n_j} p(j \mid x_i, r^F, z_i, z(j); \hat{\theta}_1)},$$

where $b_i^{K\max}$ is the credit limit of household *i* in sector *K* of the credit market; $z_{1v_i}^{K}$ is the vector of characteristics of all sector *K potential* lenders present in village v_i of household *i;* $z_{1v_i} \equiv (z_{1v_i}^{F}, z_{1v_i}^{I})$[74]; x_{1i} is a subvector of household *i*'s vector of demographic, asset, and community characteristic variables (including prices); n_{ja}^{K}/n_j is the sample proportion of households in stratum *j* with access to sector *K* credit (that is, with $b_i^{K\max} > 0$); the $p(j \mid x_i, z_i, r^F, z(j); \theta_1)$ are the estimated probability choices from the first stage of the two-step procedure; $r^F = (r_1^F, \ldots, r_{Jp}^F)$ with r_j^F being the interest rate being charged by the credit program defining stratum *j;* $x_i \equiv (x_{1i}, x_{2i})$ and $z_i \equiv (z_{1v_i}, z_{2i})$. The two vectors x_{2i} and z_{2i} are regressors in the loan demand equations. The precise list of all the regressors in x_i and in z_i is given in Table 17.

The Credit Demand Equations

For the credit demand equations we have dependent variables that are truncated at zero on the left and censored at the values of the respective credit limits on the right. Hence $\Delta_y \equiv \mathbb{R}$, $s \in \{1,2\}$ with $\Delta_{y0} \equiv \{b^* < 0\}$, $\Delta_{y1} \equiv \{0 \le b^* < b_{\max}\}$, and $\Delta_{y2} \equiv \{b^* \ge b_{\max}\}$. Therefore

$$\tilde{E}(b_i^K b_i^{\max}, \bar{r}^F, x_{2i}, z_{2i}, z(j_i)) = \hat{w}_{j_i nc}^{K} G_{j_i 2}^{K}(b_i^{\max}, \bar{r}^F, x_{2i}, z_{2i}, z(j_i); \theta_3^K) + \hat{w}_{j_i C}^{K} b_i^{K\max}$$

$$K \in \{F, I\} \equiv \{\text{formal, informal}\} \qquad \text{and} \qquad i = 1, \ldots, n.$$

$$\hat{w}_{j_i nc}^{K} \equiv w_{j_i nc}^{K}(x_i, z_i, z(j_i); \hat{\theta}_1) \equiv \frac{\dfrac{H(j_i)}{Q(j_i)} \dfrac{n_{j_i nc}^{K}}{n_{j_i}} p(j_i \mid x_i, z_i, z(j_i); \hat{\theta}_1)}{\displaystyle\sum_{j=1}^{J} \frac{H(j)}{Q(j)} \frac{n_{jnc}^{K}}{n_j} p(j \mid x_i, z_i, z(j); \hat{\theta}_1)}$$

$$\hat{w}_{j_i C}^{K} \equiv w_{j_i C}^{K}(x_i, z_i, z(j_i); \hat{\theta}_1) \equiv \frac{\dfrac{H(j_i)}{Q(j_i)} \dfrac{n_{j_i C}^{K}}{n_{j_i}} p(j_i \mid x_i, r^F, z_i, z(j_i); \hat{\theta}_1)}{\displaystyle\sum_{j=1}^{J} \frac{H(j)}{Q(j)} \frac{n_{jC}^{K}}{n_j} p(j \mid x_i, r^F, z_i, z(j); \hat{\theta}_1)}$$

[74] We note that some of the unobserved formal lender characteristics are being absorbed into the vector of program dummy variables $z(j_i)$ that is household and alternative specific. In other words, j_i or the corresponding program

where b_i^K is the amount borrowed by household i from sector K of the credit market; $b_i^{\max} \equiv (b_i^{F_{\max}}, b_i^{I_{\max}})$; $\bar{r}^F$ is the interest rate for formal credit; z_{2i}^K is a subvector of the vector of characteristics of sector K lenders who gave loans to household i; $z_{2i} \equiv (z_{2i}^F, z_{2i}^I)$; x_{2i} is a subvector of household i's vector of demographic, asset, and community characteristic variables; and n_{jc}^K/n_j and n_{jnc}^K/n_j are the sample proportions of households in stratum j with binding and nonbinding sector K credit constraints, respectively (that is, with $b_i^{*K} \geq b_i^{K_{\max}}$ and $0 \leq b_i^{*K} < b_i^{K_{\max}}$, respectively).

The Outcome Equations

The outcome equations are all estimated with any possible truncated dependent variable problems assumed to be taken care of by the use of a nonlinear functional form. Hence we have

$$\tilde{E}(y_i \mid b_i^{\max}, b_i, x_i^y, x_{ie}^y, z_{2i}, z(j_i)) = \hat{w}_{j_i} G_{j_i y}(b_i^{\max}, b_i, x_i^y, x_{ie}^y, z_{2i}, z(j_i); \theta_3^y) \qquad i = 1, \ldots, n,,$$

$$\hat{w}_{j_i} \equiv w_{j_i}(x_i, z_i, z(j_i); \hat{\theta}_1) \equiv \frac{\dfrac{H(j_i)}{Q(j_i)}\, p(j_i \mid x_i, z_i, z(j_i); \hat{\theta}_1)}{\displaystyle\sum_{j=1}^{J} \frac{H(j)}{Q(j)}\, p(j \mid x_i, z_i, z(j); \hat{\theta}_1)},$$

where y is one of the outcome variables (total income, net crop income, nonfarm income, food expenditure, calorie intake, protein intake, weight-for-age Z-score, or height-for-age Z-score); $b_i^{\max} \equiv (b_i^{F_{\max}}, b_i^{I_{\max}})$; $b_i \equiv (b_i^F, b_i^I)$; x_i^y is a subvector of household i's vector of demographic, asset, and community characteristic variables (including prices); x_{ie}^y is a subvector of the vector of outcome variables in the system excluding y (x_{ie}^y is not included in the income equations).

First Step of the Estimation Procedure: Estimation of Conditional Probability Choices

The four-alternative nested multinomial logit is specified to have two levels. At the first level, the choice is between participation and nonparticipation in a credit program (corresponding to choice $j = 0$). At the second level, which is reached only if participation is the chosen alternative, the choice is between (1) joining and remaining a member of MRFC ($j = 1$), (2) joining and remaining a member of the second program ($j = 2$), or (3) joining either MRFC or the second program and then drop-

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dummy variable stands for both the alternative choice of household i and the identity of the formal lender defining stratum j, including all of its unobserved attributes (see the discussion on identification that follows).

ping out of the program (that is, being a past member; $j = 3$).[75] MRFC is the only program operating in one of the five districts represented in the survey. Therefore the estimation imposed the restriction that households in that district not have a second program choice. Allowing for different parameter vectors for the regressors in the four alternative choices and normalizing the coefficient for the fourth alternative to zero while taking account of the fact that there is no second program in one of the five districts, the four probability choices for a household i are given by

$$P_{0i} \equiv \text{prob } \{j_i = 0\} = \frac{e^{X'_{0i}\beta_0}}{e^{X'_{0i}\beta_0} + aT_i(\gamma)^\rho},$$

$$P_{1i} \equiv \text{prob } \{j_i = 1\} = \frac{e^{X'_{1i}\gamma_1}}{T_i(\gamma)},$$

$$P_{2i} \equiv \text{prob } \{j_i = 2\} = (1 - d_i)\frac{e^{X'_{2i}\gamma_2}}{T_i(\gamma)},$$

and

$$P_{3i} \equiv \text{prob } \{j_i = 3\} = \frac{1}{T_i(\gamma)},$$

where $T_i(\gamma) \equiv 1 + e^{X'_{1i}\gamma 1} + (1 - d_i)e^{X'_{2i}\gamma 2}$ and $\gamma \equiv (\gamma_1,\gamma_2) \equiv (\beta_1/\rho,\beta_2/\rho)$ (Schmidt and Strauss 1975; Maddala 1983; Amemiya 1985; Judge et al. 1985). The X_{ji} are vectors of alternative specific regressors, d_i is a district dummy variable, and β_j, a, and ρ are the parameters to be estimated. McFadden's (1981) sequential MLE for nested multinomial logit models consists first of estimating γ from the last three equations, which constitutes a simple multinomial logit model (with the Manski-Lerman weighted MLE). The estimated γ parameter is then plugged into the first equation to get estimates of β_0, a, and ρ by means of the Manski-Lerman weighted MLE. The estimates of β_1 and β_2 are then obtained from the estimates of γ and ρ. The estimation was implemented in GAUSS using the Berndt et al. (1974) algorithm.

[75] The reason for dropping out may be either a voluntary decision on the part of the borrower or exclusion because of default. However, almost all the past members in the sample are from SACA, a failed government agricultural credit program, the operations of which have been taken over by MRFC. MRFC has offered defaulters from SACA the option of joining MRFC after agreeing on a rescheduling of payments on their SACA loans.

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