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IMPACT OF ACCESS TO CREDIT ON INCOME AND FOOD SECURITY IN MALAWI

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ABSTRACT

The paper departs from the standard practice that takes 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 household welfare. The marginal effects of the formal credit limit variable on household welfare, controlling for the credit limit from informal sources as well as the credit demanded from both sources, measure the marginal effects of access to formal credit. The main finding of the paper is that access to formal credit, by enabling households to reduce their borrowing from informal sources, has marginally beneficial effects on household annual income. However, these effects are very small and do not cause any significant difference between the per capita incomes, food security, and nutritional status of credit program members and noncurrent members. Moreover, the beneficial substitution effect reflects only the fact that reduced borrowing from informal sources makes informal loans play a lesser role in the negative impact that borrowing (from formal or informal sources) has on net crop incomes. The marginal effects on household farm and nonfarm incomes resulting from mere access to formal credit (without necessarily borrowing) are positive and quite sizable, but not statistically significant. Land scarcity and unfavorable terms of trade for the smallholders' farm products remain by far the factors that most constrain per capita household income growth in Malawi. The paper concludes that the necessary complementary resources and economic environment are not yet in place for access to formal credit to realize its full benefits for Malawi's rural population.

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1. INTRODUCTION

The political and financial support currently enjoyed by microcredit programs flows from the assumption that with improved access to credit poor rural households will be able to raise their living standards by engaging in more lucrative farm and nonfarm income activities. But do households who gain access to credit through microcredit programs improve their living conditions? And if so, how much and in what ways do households and their individual members benefit? In particular, does access to formal credit contribute to the food security of the household as a whole and improve the nutritional status of the children? Furthermore, because households often have access to informal sources of credit, how are access to both formal and informal sources of credit related in their effects on household welfare? This paper addresses these questions.

The paper departs from the standard practice that takes 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 household welfare. The shortcomings of this standard practice have been long recognized (see, for example, David and Meyer 1980; Feder et al. 1990; Zeller et al. 1996). They are directly related to the fungibility and substitutability of credit from different sources and to the endogeneity of credit demand and membership in credit programs. Therefore, to assess satisfactorily the effect of access to credit, this paper makes the distinction between *access to credit* (formal or informal) and *participation* (in formal credit programs or the informal credit market). A household has access to a particular source of credit if it is able to borrow from that source, though it may choose not to borrow. The extent of access to credit from a given source is measured by the *maximum* amount a household can borrow (*credit limit* or *credit line*) from that source. A household participates if it borrows 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, a household can do away with risk-reducing but inefficient income diversification strategies (Eswaran and Kotwal 1990) and precautionary savings that have negative returns (Deaton 1989).

The marginal effects on household welfare of the credit limit variable for formal credit, controlling for the credit limit from informal sources as well as the credit demanded from both sources, measure the marginal effects 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 welfare outcomes due to changes in the formal credit limit variables can be separated from those 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 of merely having access to formal credit) is separated from the indirect effect that arises when households exercise their options to borrow.

The methodology described above and data collected in 1995 and 1996 in a three-round survey of 404 households in 45 villages and five districts of Malawi are used to assess the marginal impact of access to formal credit on farm and nonfarm incomes, household food security, and nutritional status in Malawi. The main finding of the paper is that access to formal credit has marginally beneficial effects on household annual income because it enables households to reduce their borrowing from informal sources. However, these effects are too small to cause any significant difference between the incomes and food security of credit program members and noncurrent members. Moreover, the beneficial substitution effect reflects the fact that reduced borrowing from informal sources makes informal loans play a lesser role in the negative effect that borrowing (from formal or informal sources) has on net crop incomes.

The paper is organized as follows: section 2 presents the methodology used to measure access to credit and its effects on household welfare. Section 3 discusses the empirical model and estimation issues. Section 4 presents the empirical results related to the direct and indirect marginal effects of access to formal credit on farm and nonfarm incomes, household food security, and nutritional status. Section 5 offers some final remarks on the policy implications of the analysis.

2. MEASUREMENT OF ACCESS TO CREDIT AND ITS IMPACT ON HOUSEHOLD OUTCOMES

One of the most important policy and research questions regarding credit markets in developing countries is often posed in terms of how access to credit or its improvement translates into change in household agricultural output, income, food security, and so on. This question is central in many decisions regarding government- and NGO-supported credit programs, where the economic benefits of providing households access to credit are often compared to the economic costs of setting up these programs and delivering credit to the target households. Therefore, the meaning of the term "access to credit" and its relation to other often synonymously used credit-related concepts such as credit constraint, credit demand, and participation should be clarified first, before its impact on any outcome is assessed. The next section discusses a methodology based on the *credit limit* concept, which allows a precise definition of "access to credit" and enables a more satisfactory analysis of its impact on household welfare. (See Diagne, Zeller, and Sharma 1997 for more details on the methodology.)

CREDIT CONSTRAINT, ACCESS TO CREDIT, AND PARTICIPATION

Any borrower, however credit worthy, faces a limit on the overall amount he or she can borrow from any given source of credit. This maximum amount, arising from the limits to the resources of potential lenders, is independent of the interest rate that can be charged and the likelihood of default. Furthermore, due to the possibility of default and the lack of effective contract enforcement mechanisms, lenders have the incentive to further restrict credit supply even if they have more than enough to meet a given demand and a borrower is willing to pay a high interest rate (Avery 1981; Stiglitz and Weiss 1981).

The credit limit—the maximum the lender is *willing* to lend—is referred to here as b_{max} and is the focus of the methodology. For any potential borrower, the lender's optimal choice of b_{max}, interpreted here as credit supply, is a function of the maximum amount the lender is *able* to lend and a subjective assessment of the likelihood of default and other borrowers' characteristics. The lack of access to credit from a given source of credit can be defined as the b_{max} for that source of credit equaling zero. That is, access to a certain type of credit exists when b_{max} for that type of credit is positive; and access improves when b_{max} for that type of credit increases.

Access to formal credit is often confused with participation in formal credit programs. The two concepts are used interchangeably in many credit studies. The crucial difference between the two is that households freely choose to participate in a credit program, but their access to a credit program is constrained by various factors, including eligibility criteria and availability of credit programs. In other words, participation is more of a demand-side issue related to the potential borrower's choice of the optimal loan size b^*, while access is more of a supply-side issue related to the potential lender's choice of the credit limit b_{max}.

IMPLICATIONS FOR THE MEASUREMENT OF THE EFFECTS OF ACCESS TO CREDIT

If *access to credit* and *improvement in access to credit* are identified respectively with a *strictly positive* and *increasing* credit limit, b_{max}, measuring the impact of access to credit means measuring the effects of an increase in b_{max} on household behavior and welfare. This interpretation of the objective of public intervention in the credit market as one of increasing the credit limit of poor credit-constrained households (instead of actually giving out credit) has methodological implications.

Most studies on the impact of credit programs on household outcomes take the effect of an additional unit of credit received by a household as the effect of the credit program on those households. What is evaluated in these studies is $\partial y / \partial b^*$, where y is a household outcome variable (see, for example, Pitt and Khandker 1995). The hypothesis being tested is the existence of a positive relationship between credit received and various household outcomes. These types of impact studies have been long criticized, notably by David and Meyer (1980), for reasons related to the problems of substitutability and fungibility of credit from different sources. Indeed, the usefulness of such an approach for policy is limited unless one assumes that all households in the program 1) had credit constraints when they received credit, 2) had the program as their only source of credit, and 3) were unable to use their own resources to finance even a part of their investments (Feder et al. 1990). However, most households have access to some form of informal credit and use various saving 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 households demand when such credit becomes available is likely to reflect some substitution away from other sources of investment funds. These substitution effects alone make it inappropriate to identify the effects of access to formal credit with the effects of changes in the 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. First, some households may have access to sufficient credit lines from the program, but decide not to borrow because it is not optimal for them to do so. Yet, the sufficient credit lines provided by the program to these nonborrowing households may have a positive effect (by allowing these households not to engage in unproductive precautionary savings, for example). Emphasis on the amount borrowed would not account for such an effect. Second, 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" provided by the sufficient credit lines that allowed the borrowing of such large amounts.

The same criticism applies to the other common practice of equating the effects of membership in a credit program on household welfare with the effects of access to formal credit. The wider literature on program evaluation demonstrates that if proper survey design, sample selection, and econometric analysis resolve the problem of endogeneity of membership status and credit program placement, then the estimated partial effects of the membership status variable would correctly measure the average effects of the credit program on household welfare (see, for example, Heckman and Smith 1995, Moffitt 1991, Pitt and Khandker 1995, and Morduch 1997). In fact, most of the recent literature on the difficulties of measuring the effects of credit programs concentrates on the statistical problems related to survey design, sample selection, and endogeneity of program placement, neglecting the issues related to substitution and fungibility, which are somewhat specific to credit programs. "Program effects" measured through the membership status variable do not measure the effects of access to formal credit, and the two may not even correlate. There are at least two reasons why this is so. First, most microcredit programs provide an array of additional services besides credit (literacy classes, business training, family planning education, and so on). Therefore, the measure of the impact of these programs on welfare outcomes includes the effect of changes in behavior as a result of educational services (Pitt and Khandker 1995). Second, membership in a credit program does not guarantee access to its credit. In fact, many group-based microcredit programs (for example, two of the five studied in this paper) stipulate explicitly that at any point in time only half of the group members can have access to their credit.[1] Even the microcredit programs that do not have this rule, but

[1]This is an incentive repayment device aimed at inducing nonrecipients to put pressure on the recipients to repay their loans. The nonrecipients will be able to borrow only if all members in the first half have fully repaid their loans. This implies that nonrecipient members will be waiting indefinitely in case of default.

operate within ad hoc or continuously evolving institutional arrangements (especially those that depend on short-term donor funding), provide their members with less than certain access to credit.[2]

In summary, because neither the partial effects of credit received nor membership in a credit program necessarily correlate with the benefits of access to formal credit, they cannot be taken as measures of the effects of access to formal credit on household welfare. Therefore, unless one is concerned with measuring "program effects," the credit limit b_{max} is the appropriate variable for measuring the effect of access to formal credit on household welfare. Furthermore, the survey design and sample selection requirements for correctly identifying the effects of b_{max} on household welfare are less stringent than those for identifying "program effects" with the membership status variable. Indeed, since b_{max} is a continuous variable that is likely to vary through time and among credit program members (especially if they belong to different programs), the impact of access to formal credit on household welfare can still be identified and measured even if only credit program members constitute the sample. The estimates in this case, however, are conditional.[3] In contrast, it is impossible to measure "program effects" without a sample containing both members and nonmembers of credit programs. Moreover, a quasi-experimental survey

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[2]Members of one of the microcredit programs studied in the paper, The Mudzi Fund, could not borrow from their organization for several months, because it was being incorporated into a larger credit program (MRFC).

[3]There are important identification issues to be discussed below. These are related to the fact that the lender's choice of b_{max} depends on the borrower's characteristics.

design is likely to be necessary in order to have a sample that allows a correct identification of "program effects" (Pitt and Khandker 1995).

3. MODEL SPECIFICATION

In this section, the effects of access to formal credit on household welfare are estimated using a reduced form model to determine (1) the household's credit limits from formal and informal sources of credit, (2) household demand for formal and informal credits, and (3) household welfare issues of interest. The section focuses on three aspects of household welfare, the improvement of which are the stated objectives of microcredit programs: income, food security, and nutritional status of children. Food security is measured by daily calorie and protein intake, and the nutritional status of children is measured by weight-for-age and weight-for-age Z-scores. However, the determinants of farm and nonfarm incomes, and of food, are estimated as part of the reduced form model.

The reduced form equations for the credit limits, the demands for credit, and income 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 (see Diagne 1996; Diagne, Zeller, and Sharma 1997). The reduced form equations for calorie and protein intake and nutritional status can be deduced by extending the basic household utility maximization model into a Becker-type household production framework (see, for examples, Alderman and Garcia 1994; Pitt and Khandker 1995). Then the following reduced form linear equations are postulated:

$$b_{max}^{F} = \alpha_1 x_1 + \beta_1^F z_1^F + \varepsilon^F , \tag{1}$$

$$b_{max}^{I} = \alpha_2 x_2 + \beta_1^I z_1^I + \varepsilon^I , \tag{2}$$

$$b^{F} = \alpha_3 x_3 + \beta_2^F z_2^F + \delta^F r + \gamma_1^F b_{max}^{F} + \gamma_1^I b_{max}^{I} + u^{F} , \tag{3}$$

$$b^{I} = \alpha_4 x_4 + \beta_2^I z_2^I + \delta^I r + \gamma_2^F b_{max}^{F} + \gamma_2^I b_{max}^{I} + u^{I} , \tag{4}$$

and

$$y = \alpha_5 x_5 + \beta_y z_y^F + \gamma_y^F b_{max}^{F} + \gamma_y^I b_{max}^{I} + \theta^F b^{F} + \theta^I b^{I} + v , \tag{5}$$

where b_{max}^{F}, b_{max}^{I}, b^{F}, and b^{I} are the credit limits and amounts borrowed for formal and informal credits, respectively, and y is a generic household welfare variable. For x_i, $i=1,2,\ldots,5$, where each i represents a vector of household demographics and assets, community characteristics, and prices. z^{F} and z^{I} are vectors of characteristics for formal and informal lenders and r is the (transaction-cost-adjusted) formal interest rate.[4] Finally, α, β, γ, δ, and θ are the parameters to be estimated, and ε, u, and v are error terms.

[4]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.

Using equations (5), (3), and (4), 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):

$$\frac{\partial E(y|x_5, z_y^F, b_{max}^F, b_{max}^I, b^F, b^I)}{\partial b_{max}^F} = \gamma_y^F + \theta^F \frac{\partial b^F}{\partial b_{max}^F} + \theta^I \frac{\partial b^I}{\partial b_{max}^F} = \gamma_y^F + \theta^F \gamma_1^F + \theta^I \gamma_2^F . \qquad \textbf{(6)}$$

As equation (6) shows, γ_y^F measures the direct marginal effect on *y* of merely having access to formal credit. It is hypothesized that this direct effect is positive for most welfare outcomes because, as argued above, the option to borrow, even if not exercised, should reduce the household's (low- or negative-return) precautionary savings and its needs for risk-reducing but inefficient income diversification strategies.[5] However, gaining and maintaining access to a source of credit is rarely costless as potential borrowers often are 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. If these costs outweigh the direct benefits, then γ_y^F may end up being negative.

The product $\theta^F \gamma_1^F$ measures the marginal effect of access to formal credit on *y* when the household exercises its option to borrow. Assuming that the loan thus obtained is used in a productive investment, one can expect $\theta^F \gamma_1^F$ to be positive for most

[5]Note that this implies that γ_y^F can be different from zero for households whose credit constraints are not (*ex post*) binding. In other words, equations (3)-(5) apply to both *ex post* constrained and unconstrained households and the estimated coefficients will measure average marginal effects across both types of households. For *ex post* unconstrained households, having a positive b_{max} is like having an insurance against a liquidity constraint.

components of welfare (at least in the long run). However, $\theta^F \gamma_1^F$ may be negative in the short run for some welfare components. 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, for example, to a negative $\theta^F \gamma_1^F$ for calorie intake.

The product $\theta^I \gamma_2^F$ is the marginal effect of access to formal credit on y due to substitutability between formal and informal credit. This is a *gross* substitution effect obtained without holding the household utility (or overall welfare) constant when access to formal credit is changed. Therefore, it includes both the *pure* substitution effect (obtained by holding utility constant) and the income or welfare effect. By definition, the pure substitution effect does not have any (overall) effect on welfare.[6] But it cannot be separated from the income or welfare effect in this reduced form specification.[7] Therefore, the gross substitution effect can be different from zero, but its sign on any welfare outcome equation can be either positive or negative depending on whether informal credit and formal credit are (gross) substitutes or complements (indicated by the sign of γ_2^F), and on how informal credit is related to the welfare outcome in question (that is, the sign of θ^I).

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

[7]The two effects can be separated only with a structural model.

If the amount borrowed was used to measure the marginal impact of access to credit on *y*, one would obtain θ^F. This implies the following restrictions: (1) $\gamma_1^F = 1$ (households are always credit constrained and would borrow the full amount of any increase in their credit lines), (2) $\gamma_2^I = 0$ or $\theta^I = 0$ (formal and informal credit are not substitutable or households do not used informal credit even if they have access to it), and (3) $\gamma_y^F = 0$ (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 the characteristics of formal lenders) to measure the impact of access to credit on *y* implies the same restrictions along with the restriction that $\theta^F = 0$.

IDENTIFICATION OF THE MODEL

Equations (1) through (5) form a recursive system of simultaneous equations, with the exogenous variables constituted by the household demographics and assets, community characteristics, and lenders' characteristics appearing in all equations. Hence, exclusion restrictions on these variables are needed to identify the system. The simultaneity of the credit limit variables (which are choice variables for lenders, not borrowers) results from the fact that the variables are likely to be correlated with the unobservable household characteristics absorbed into the error terms *u* and *v*. (Unobservable characteristics could include a household's likelihood to default.) Any household demographic, community characteristics, and prices observed by the econometrician are probably observable by informal lenders. The same can be said for formal lenders, especially those that use the group-based lending technology popularized by the Grameen Bank. In addition, these observable factors are likely to determine both lenders' choices of credit limits and borrowers' choices of loan sizes. Therefore, as argued by Udry (1995), one should not expect to find exclusion restrictions on these sets of variables in order to identify equations (3) and (4).

The main argument used in this study to identify equations (3) and (4) is that not *all* the variables for a lender's characteristics enter directly into determining the amount borrowed. That is, some of the lender's characteristics influence the amounts borrowed *only through* the effects they have in determining how much the lender is willing to lend. For informal credit, the information collected on the lender's characteristics are: relative wealth compared to the borrower, professional occupation, relation to the borrower, place of residence, and whether he or she is a member of a credit program. All these characteristics influence the amounts borrowed only through the informal credit limit. For formal credit, the only available information on the lender's characteristics is for the program dummy variables.[8] These program dummies, which stand for the formal lenders'

[8] All the other potential variables (such as source of program funding, whether the program is for agricultural inputs or for nonfarm income, and so on) turned out to be perfectly correlated with the program dummies.

identities and other unobserved specific attributes, influence the amounts borrowed only through the formal credit limit.[9, 10]

Finally, to identify the outcome equation (5), reasonable exclusion restrictions on household demographics, community characteristics, and prices are used (see the tables of results in the appendix for details). In addition to these restrictions, other exclusion restrictions used (and implicit in the equation) are that the formal interest rate and informal lenders' characteristics affect household welfare outcomes only through the amounts of credit demanded and the informal credit limit, respectively. On the other hand, formal lenders' characteristics are allowed to influence household welfare outcomes directly because, as already mentioned, most microcredit programs provide educational services aimed at inducing behavioral changes that would directly improve household welfare. However, because the only formal lenders' characteristics in the estimated model are the dummy variables identifying the different programs, the estimated effects of the program dummies reflect mostly the effects of their targeted nature and self-selection. These

[9]One can conceive of circumstances in which the lender's identity influences directly the size of the loan sought by a borrower. For example, borrowers may be willing to borrow more from lenders with lax credit recovery systems compared to those who punish default harshly, even if the credit limits from both sources are the same. This possibility is ruled out for the purpose of identifying the model.

[10]Only the characteristics of those lenders whose loan transactions were recorded are used as instruments. Unfortunately, we did not collect the characteristics of lenders for households that were not involved in any loan transaction (although their b_{max} were collected). The information could have been collected but we became aware of the problem too late in the survey for it to be collected. The characteristics of formal and informal lenders used in the estimation are all in the form of dummy variables, which were set to zero for households not involved in any loan transaction.

effects cannot be separated from the effects of the additional services provided by the programs because of the nonexperimental nature of the sample-selection process.

SAMPLING AND ESTIMATION METHODOLOGIES

The data used in the analysis come from a year-long three-round survey (February 1995 through December 1995) of 404 households in 45 villages in 5 districts of Malawi. Four local microcredit programs were studied. The four programs are: Malawi Rural Finance Company (MRFC, a state-owned and nationwide agricultural credit program), Promotion of Micro-Enterprises for Rural Women (PMERW, a microcredit program for nonfarm income generation activities supported by the Deutsche Gesellschaft für Technische Zusammenarbeit, The Malawi Mudzi Fund (MMF, a program funded by the International Fund for Agricultural Development and modeled on the Grameen Bank and now incorporated into MRFC), and the Malawi Union of Savings and Credit Cooperatives (MUSCCO, a union of locally based saving and credit unions). All the programs are based on group lending except MUSCCO.

If the sample could have been drawn randomly, then, given the above identifying restrictions, the system could have been estimated straightforwardly using standard simultaneous equation estimation methods. However, despite the existence of numerous credit programs in Malawi, participation is rare. Out of 4,700 households enumerated in the 45 villages covered by the village census, only 12 percent were current members of a credit program. Moreover, the 12 percent figure significantly overstates the likelihood of credit program membership because it represents the percentage of membership in villages that are actually hosting the four credit programs studied. The majority of villages in Malawi do not host any credit program. The low participation rate ruled out at the outset straight random sampling at any geographical level beyond the village level. The only feasible alternative was to stratify along the program membership status variable, with random selection within each stratum. About half of the sample was selected from participants of the four credit programs. The other half of the sample was equally divided between past participants (mostly from a failed government credit program) and households that had never participated in any formal credit program. For details on the survey and data collection methodology, see Diagne, Zeller, and Mataya 1996.

Under the circumstances stated above, not only is the chosen method of choice-based sampling more cost-efficient than straight random sampling, but it yields estimates with better statistical properties than those obtained under straight random sampling, provided the appropriate estimation methods are used (Manski and McFadden 1981; Cosslett 1981 and 1993; Amemiya 1985). Appendix 1 shows that the choice-based sampling correction required when estimating the system (equations [1] through [5]) involves only the equations where the program dummies appear as regressors. Moreover, the correction consists merely of replacing the program dummies by the corresponding choice-based-corrected conditional probability choices. The choice-based corrected equations have the following form:

$$\tilde{E}(y_i|x_i) = \alpha x_i + \sum_{j=1}^{J-1} \beta_j w_{j_i} \quad i=1,\ldots,n\ , \tag{7}$$

where y and x are generic dependent variable and regressor, respectively, α and β_j are the parameters to be estimated. and

$$w_j \equiv \frac{\frac{H(j)}{Q(j)} p(j|x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j|x)} \quad j=1,\ldots,J \tag{8}$$

are the choice-based-corrected conditional probability choices. The indexes $j=1,\ldots,J$ are the mutually exclusive J program choices defining the strata, and j_i designates the stratum of the i^{th} household. $p(j|x)$ is the population conditional-choice probability that program j is chosen given x. $H(j) \equiv n_j/n$ and $Q(j) \equiv N_j/N$ are the respective sampling and population ratios, with n_j (respectively, N_j) being the size of the sample (respectively, population) strata defined by program j, and n and N being, respectively, the total sample and population sizes. Note that the calculation of the partial effects of any variable in a equation corrected for choice-based sampling has to take into account the changes in w_j if that variable appears also as a regressor in the estimation of $p(j|x)$.

A two-stage estimation method similar to Heckman's two-step procedure for Tobit models is used to estimate equation (7). In the first stage, the Manski-Lerman weighted maximum likelihood estimator is used to consistently estimate the conditional probability choices $p(j|x)$ and construct the w_j.[11] In the second stage, the estimated w_j are used in equation (7) to estimate each resulting equation with an Ordinary Least Squares (OLS) or a Two-Stage Least Squares (TSLS) procedure, depending on the equation.

A four-alternative two-level nested multinomial logit model is used to estimate the population conditional choice probabilities (see Appendix 1 for details). However, the model allows the vector of parameters to be different across the four alternative choices (Judge et al. 1985; Maddala 1983; Schmidt and Strauss 1975). The four mutually exclusive alternative choices correspond to (1) being a member of MRFC, (2) being a member of one of the other three microcredit programs (Mudzi Fund, MUSCCO, or PMERW), (3) being a past member of a credit program, and (4) never having been a member of a credit program. This classification 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, which are generically called PROG2 (choice variable) in the estimated model. However, the program dummy variables (Mudzi, MUSCCO, and PMERW) were used as alternative-specific regressors instead of the generic label. As usual in a multinomial discrete choice model, these dummy

[11] The ratio $Q(j)/H(j)$ is the sample analogue of the Manski-Lerman weight used in the weighted maximum-likelihood procedure to get consistent estimates under choice-based sampling (see Manski and McFadden 1981 or Amemiya 1985, chapter 9).

alternative-specific variables control for unobserved attributes specific to each alternative. These attributes can explain why a household prefers one alternative over another. In fact, for PMERW, its two sister programs (designated here as PMERW1 and PMERW2) are differentiated because of their different attributes and target groups.[12] Therefore, the partial effects for all the program dummies are estimated for both the conditional probability choices and for the equations, including the three choice-based-corrected conditional probability choices for MRFC, PROG2, and past members (these are the w_j above). The three choices are called WMRFC, WPROG2, and WPAST in the tables reporting the results of the estimation.[13]

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) was used to calculate standard errors for all the estimated conditional probability choice parameters and the subsequently estimated simultaneous equations system. (The Bootstrap method is implemented by replicating, with replacement, the sampling procedure used to select the households.) To account for the possibility of the

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[12]PMERW1 is a revolving fund targeted to very poor women while PMERW2 operates through one of the main commercial banks in Malawi as a loan guarantee scheme. PMERW2 members are either "graduates" of PMERW1 or successful but not very wealthy business women living in the areas covered by the program.

[13]All the partial effects are calculated for each household before taking weighted averages across households. This is preferable to evaluating partial effects at the means because of the nonlinearities in the probability choices (all estimations and computations were performed with GAUSS).

instruments being only weakly correlated with the endogenous variables, the relevant F statistics and exogeneity and overidentification test statistics were computed for each equation following Staiger and Stock (1997).

4. EMPIRICAL RESULTS

THE DATA

The survey includes information on household demographics, land tenure, agricultural production, livestock ownership, asset ownership and transactions, food and nonfood consumption, credit, savings and gift transactions, wage, self-employment income and time allocation, and anthropometric status of preschoolers and their mothers. The agricultural data cover the 1993/94 and 1994/95 seasons. Because the methodology used in this paper to assess the effects of access to credit on household welfare is based on the credit limit, few details will be given on the way the credit limit variable was collected in the survey.

The questionnaire on credit and savings was administered to all adult household members (over 17 years old) in the sample. In each round, respondents were asked what was the maximum amount they *could* borrow during the recall period from both informal and formal sources of credit. If the respondent borrowed or tried to borrow, the question was asked for each loan transaction (both for granted and rejected loan demands). The credit limit in these transactions refers to the time of borrowing and the lender involved. 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 received 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 more loans, not just from the same lender, but from the same sector of the credit market (formal or informal). Consequently, for both formal and informal credit, the maximum formal and informal credit limits of each adult household member were obtained in each round, even if the member was not involved in any loan transaction.

The Distribution of Formal and Informal Credit Limits[14]

Table 1 presents the average maximum informal and formal credit limits from October 1993 to December 1995 for the whole population and for formal sector borrowers only.[15] In particular, the table shows that the average maximum formal and informal credit limits for the population as a whole are 167 and 99 Malawi Kwacha (MK), respectively.[16] The corresponding figures for formal sector borrowers were 675 and 90 MK, respectively. To put these figures in perspective, Malawi's 1995 per capita GNP was

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[14]All the summary statistics have been weighted using the strata population weights from the village census and the district-level 1987 population census data.

[15]To correct for the over sampling of credit program participants, the summary statistics in the tables have been weighted using the strata population and sample ratios ($Q(j)/H(j)$), which were corrected with weights constructed using the district-level 1987 population census data.

[16]The exchange rate is US$1 for 15 Malawi Kwacha (MK).

US$170 (2,550 MK) and the average per capita 1995 income in the sample was 1,190 MK. The box plot diagrams of the distributions presented in Figure 1 give a better

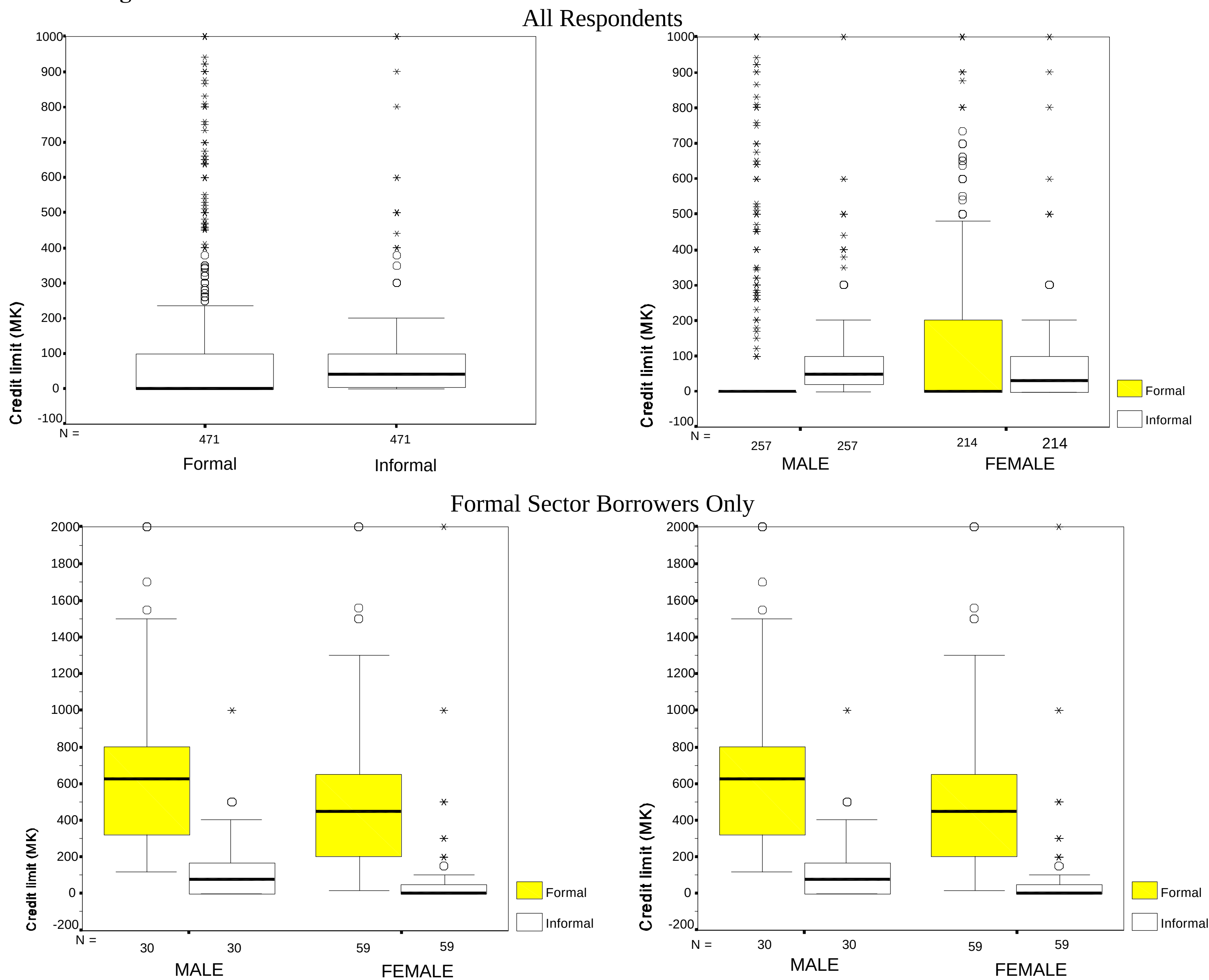
Table 1 Formal and informal credit limits in Malawi (October 1993 to December 1995)

Credit limits	All respondents		Formal sector borrowers only	
	Formal	Informal	Formal	Informal
	(MK)[a]			
Mean	167	99	675	90
Median	0	40	500	20
Standard deviation	497	354	911	499
Minimum	0	0	13	0
Maximum	10,000	12,000	10,000	12,000

Source: International Food Policy Research Institute and Rural Development Department, Bunda College of Agriculture, Rural Finance Survey, 1995.

[a] US$1 = 15 Malawi Kwacha (MK).

Figure 1 Distribution of formal and informal credit limits in Malawi (October 1993 to December 1995): Box plot diagrams



Notes: Box plot diagrams are interpreted as follow: For each box, 50 percent of cases have values within the box and the solid horizontal line inside 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 (respectively, 75th) percentile. Finally, the circles are outliers and the stars are extreme values. The exchange rate is US$1 = 15 MK. Malawi's 1995 per capita GNP was US$170 (2,550 MK).

picture of the extent of access to credit in Malawi. The figure shows that the median formal and informal credit limits in the population as a whole are, respectively, zero and 40 MK. Fifty percent of the population can borrow at most 100 MK (less than US$10) from either sector of the credit market. Formal sector borrowers have a higher median formal credit limit (375 MK) but a lower median informal credit limit (20 MK). This likely reflects of the fact that two of the credit programs studied are targeted to poor women who might have been excluded from the few existing sources of informal credit because of their socioeconomic situation (see Figure 1).

Household Income

Table 2 shows that the average 1995 per capita total household income in the survey areas was 1,190 MK for 1995 and 986 MK for 1994. The average per capita crop income in the drought year of 1994 (161 MK) is half the average crop income for 1995. This shows the high income risk that agricultural households relying only on crop production have to face in Malawi. On the other hand, nonfarm income generating activities, which are presumably less dependent on weather, may be not only a less risky source of income, but also a substantial source of income for rural households (more than twice the average crop income). Finally, the average per capita total income of credit program participants in 1994 (1,559 MK) and 1995 (1,833 MK) is almost twice as high as that of past participants (756 and 1,017 MK, respectively) and that of households who never participated in any credit program (856 and 1,025 MK, respectively).

Table 2 Household per capita incomes, food expenditure, calorie intake, and nutritional status: By credit program membership

	All households	Current members: MRFC	Mudzi Fund	MUSCCO	PMERW1	PMERW2	Other	All	Past members	Never been members
Total income (MK)[a]										
1994	986	1,565	1,389	805	1,039	2,844	1,567	1,559	756	856
1995	1,190	1,843	1,493	1,471	1,212	4,204	1,978	1,833	1,017	1,025
Crop income (MK)										
1994	161	155	–76	227	49	249	397	154	166	161
1995	365	433	28	893	223	1,608	809	429	427	330
Nonfarm income (1995, MK)	825	1,410	1,465	578	989	2,596	1,170	1,404	590	695
Monthly food expenditure (MK)	129	112	137	104	113	142	173	120	94	140
Daily calorie intake (Kcal)	2,184	1,949	2,168	2,083	1,985	2,094	1,984	1,979	1,901	2,313
Average share of food out of total consumption	88%	86%	80%	87%	84%	83%	85%	86%	91%	88%
Average share of food out of total cash expenditure	71%	75%	73%	64%	75%	76%	74%	74%	71%	70%
Height-for-age										
–1 s.d. below reference	66%	72%	77%	72%	79%	71%	83%	74%	72%	62%
–2 s.d. below reference	46%	55%	49%	53%	58%	45%	43%	53%	61%	39%
Weight-for-age										
–1 s.d. below reference	46%	55%	40%	49%	45%	37%	60%	52%	51%	42%
–2 s.d. below reference	16%	20%	8%	18%	19%	13%	2%	17%	21%	15%

Source: International Food Policy Research Institute/Rural Development Department, Bunda College of Agriculture (IFPRI/RDD), Rural Finance Survey, 1995.

Notes: The 1994 nonfarm income information was not collected, but it is assumed to be the same as for 1995. Total food expenditure includes the imputed value of food out of home production. Kcal stands for kilocalories; s.d. for standard deviation.

[a] US$1 = 15 MK.

Household Expenditures and Calorie Intake

Table 2 shows that the average household per capita monthly total expenditure in the survey areas is 129 MK, with a relatively high share of food in the household monthly consumption budget (88 percent, including the imputed value of home produced food). The average per capita daily intake in the sample was 2,184 kilocalories, which is close to the 2,200 kcal/person/day recommended for Malawi. The average per capita daily calorie intake of households who never participated in any credit program is higher than that for any of the participants of the credit programs studied. This suggests that participants may not be spending their increased income on food; or if they do, they are spending it on luxurious foods with relatively lower calorie content.

Household Nutritional Status

Table 2 shows that 46 percent of preschoolers in the survey areas are chronically malnourished as measured by the height-for-age Z-scores and are thus stunted. This is close to the 48.6 percent figure for children under five years of age found in Malawi's 1992 Demographic and Health Survey. As measured by the weight-for-age Z-scores, 16 percent of preschoolers are acutely malnourished. Finally, households who never participated in any credit program have the lowest prevalence of chronic malnutrition among preschoolers (39 percent compared to an average of 53 percent for all participants, and 61 percent for past participants). However, the weight-for-age figures show only a slight difference in the prevalence of acute malnutrition between households that never participated and participating households as a whole (15 percent and 17 percent respectively).

MARGINAL EFFECTS OF ACCESS TO CREDIT ON HOUSEHOLD WELFARE

The system of equations (1) through (5) was estimated using the two-stage methodology outlined in Section 3. The results of the estimation are presented in Tables 3-14.[17] The relevant *F* statistics and exogeneity and overidentification test statistics are also presented for each equation. In particular, the high *F* statistics for the joint significance of the lenders' characteristics (the program dummies) in the formal credit limit equation ($F_{3,1505}$ =50.41) should be noted. On the other hand, the *F* statistics for the joint significance of the informal lenders' characteristics in the informal credit limit equation is relatively low ($F_{7,1505}$ =3.88). The informal lenders' characteristics may introduce biases in the TSLS estimates of the credit demand equations due to their weak correlations with the informal credit limit (Staiger and Stock 1997). Furthermore, for both the formal and informal credit demand equations, The Wu-Hausman and Durbin tests fail to reject the null hypothesis of exogeneity of the presumed endogenous variables. The overidentifying restrictions are also rejected by the Basmann test.[18] Under these conditions, it is more

[17]The estimation results for the conditional probability choices are reported and discussed by Diagne (1997), who also discusses the estimation procedure in greater detail.

[18]When the instruments are weakly correlated with the endogenous regressors, Staiger and Stock (1997) recommend using the Durbin and Basmann tests when testing the exogeneity and overidentification restrictions, respectively. The Basmann test uses the Limited Information Maximum Likelihood (LIML) estimates.

appropriate to estimate the two credit demand equations with OLS. The reported results are OLS estimates. The reported results for the food expenditure and calorie intake equations are also OLS estimates, for similar reasons.[19]

Access to Credit and the Demands for Formal and Informal Credits

In order to focus on the assessment of the effects of access to formal credit on household welfare and keep the paper short, only results for the credit limits and loan demands directly relevant to the impact equations are discussed. For a full discussion of the access and participation equations, see Diagne 1997. In Tables 3 through 6, the following facts are relevant for the impact assessment:

1. All five credit programs have contributed statistically significantly to the access their member households have to formal credit. Differences with noncurrent members range from as low as 20 MK per capita per season for MRFC to as high as 57 MK per capita per season for PMERW1.
2. The estimated average marginal propensity to borrow out of every additional MK of formal credit made available (FLOANMAX) is estimated at 0.49 and is statistically significantly different from both zero and 1 (at the 5 percent level). Hence, households are on *average* marginally constrained in their

[19] For the credit demand equations, there was not much difference between the TSLS and OLS estimates. There were, however, noticeable differences between the TSLS and OLS estimates for the food expenditure and calorie intake equations.

Table 3 Formal credit limit equation (FLOANMAX): Matrix of direct and indirect partial effects of selected variables

	Direct effect[a]		Indirect effect through the probability choices		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	–2,534.62	343.0319			–2,534.62	343.0319
MRFCH			19.6259	3.9254	19.6259	3.9254
MUDZIH			54.0689	7.6468	54.0689	7.6468
MUSCOH			33.7595	6.2161	33.7595	6.2161
PMERW1H			56.8125	8.0875	56.8125	8.0875
PMERW2H			56.4310	7.7808	56.4310	7.7808
WMRFC	2,913.05	309.66			2,913.05	309.66
WPROG2	2,928.46	322.59			2,928.46	322.59
WDPAST	2,790.41	328.91			2,790.41	328.91
FPDEFLT	–20.7784	13.8852	–2.7817	0.8726	–23.5600	13.7048
DP9495	–10.8881	4.6691			–10.8881	4.6691
LANDAREH	7.0622	5.7895	0.4440	0.8846	7.5062	6.0081
AGLPAREA	0.2929	0.3149	0.2658	0.0757	0.5587	0.3190
TASSETVH	0.0017	0.0033	0.0009	0.0004	0.0026	0.0032
LDPASSTH	–79.3011	28.5800	15.3997	6.2558	–63.9014	29.9756
LVPASSTH	–46.0946	34.1626	–7.2518	10.3868	–53.3463	37.0432
YYEDUCH	–0.0618	2.4691	–0.6180	0.5209	–0.6798	2.4549
YYEDUCS	2.4703	2.7511	1.5237	0.5690	3.9940	2.7320
POPADL15	–19.6817	5.4872	9.0646	1.5756	–10.6171	5.7452
DEPRATIO	–90.6065	33.2885	35.7310	7.5305	–54.8756	34.9863
AGEH	–0.0063	0.5270	–0.0244	0.0977	–0.0307	0.5538
MALEHEAD	–18.3682	16.3404	5.8149	2.4588	–12.5533	16.5945
PVMAIZE	5.9506	4.5373	–1.7266	0.9757	4.2240	4.8009
PPTOB95	3.9528	2.9707	–0.0950	0.4106	3.8578	2.9262
PVOXEN	0.0062	0.0102	–0.0042	0.0045	0.0020	0.0111
PVCATL	0.0341	0.0143	0.0183	0.0037	0.0524	0.0146
PVGSHP	–0.8954	0.3711	–0.0881	0.0635	–0.9835	0.3691
PVCHKD	0.0218	0.0188	–0.0022	0.0026	0.0196	0.0189
NWLSBUY	21.7647	7.6705	1.7904	1.2270	23.5552	7.8415
DISTFA	–4.1433	2.0048	–1.5329	0.2872	–5.6762	2.0243
DISTPO	6.7724	2.2097	0.6807	0.1656	7.4531	2.2246
DISTPSCH	6.1053	5.9583			6.1053	5.9583
DISTTCEN	–5.5751	2.2008			–5.5751	2.2008
SOUTH	–72.9070	47.1576			–72.9070	47.1576

R-squared = 0.20
F-stat. (all coefficients): $F_{(49,1458)} = 7.38$
F-stat for the program dummies: $F_{(3,1505)} = 50.41$
F-stat for all instruments[2]: $F_{(27,1481)} = 9.15$

Note: These are the exogenous regressors used as instruments in some of the other equations of the system: WMRFC WPROG2 WPAST PVMAIZE PVCASVA PVBEANS PVVEGFRT PVMEAFSH PVDRINK PVOTHER PPTOB95 PVOXEN PVCATL PVGSHP PVCHKD CDTH3Y CILLAC3Y PHVKM PSVKM NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVGAPYYP.

[a] The column of direct effects corresponds to the estimated coefficients of the variables included in the equations.

Table 4 Informal credit limit equation (ILOANMAX): Estimated coefficients of selected variables (partial effects)

	Partial effect	
Independent variable	Estimated coefficient	Standard error
CONSTANT	88.7567	39.7190
RELALEND	0.7911	5.3971
SHTRADEL	–9.8742	9.5635
FARMLEND	–7.9653	5.9776
MALELEND	10.0884	6.4531
RICHLEND	8.4306	10.0360
SVLGLEND	8.2313	5.6507
NGOLEND	24.5043	9.7688
FPDEFLT	2.1497	3.5205
DP9495	–4.0459	2.3682
LANDAREH	5.9994	2.0169
AGLPAREA	–0.0779	0.0937
TASSETVH	–0.0000	0.0005
LDPASSTH	–26.9211	8.4329
LVPASSTH	–26.2156	8.4539
YYEDUCH	0.8625	0.7060
YYEDUCS	0.1897	0.6052
POPADL15	–0.9945	1.3143
DEPRATIO	–17.6419	6.5542
AGEH	–0.2330	0.1454
MALEHEAD	–4.3006	3.9398
DISTPO	–0.6407	0.4969
PVMAIZE	–1.0145	2.3822
PPTOB95	–0.8183	0.4166
PVOXEN	0.0052	0.0038
PVCATL	0.0039	0.0052
PVGSHP	–0.0618	0.0541
PVCHKD	0.0062	0.0051

R-squared = 0.12
F-stat. (all coefficients): $F_{(56,1451)} = 3.47$
F-stat lender characteristics[a] : $F_{(7,1501)} = 3.88$
F-stat for all instruments[b]: $F_{(31,1477)} = 2.60$

[a] RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND.

[b] These are the exogenous regressors used as instruments in some of the other equations of the system: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND PVMAIZE PVCASVA PVBEANS PVVEGFRT PVMEAFSH PVDRINK PVOTHER PPTOB95 PVOXEN PVCATL PVGSHP PVCHKD CDTH3Y CILLAC3Y PHVKM PSVKM NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVGAPYYP

Table 5 Formal credit demand equation (FLOANVAL): Matrix of direct and indirect partial effects of selected variables

	Direct effect[a]		Indirect effect through FLOANMAX		Indirect effect through ILOANMAX		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	2.1633	17.2245					2.1633	17.2245
FLOANMAX	0.4887	0.0873					0.4887	0.0873
ILOANMAX	-0.0411	0.0435					-0.0411	0.0435
MRFCH			9.5921	2.0898			9.5921	2.0898
MUDZIH			26.4259	3.8919			26.4259	3.8919
MUSCOH			16.4998	3.0489			16.4998	3.0489
PMERW1H			27.7668	4.0558			27.7668	4.0558
PMERW2H			27.5804	3.8885			27.5804	3.8885
WMRFC			1,423.73	192.06			1423.73	192.06
WPROG2			1,431.26	191.69			1431.26	191.69
WDPAST			1,363.80	196.57			1363.80	196.57
DP9495	13.6721	2.8850	-5.3215	2.1320	0.1662	0.2369	8.5168	3.8359
FWEEKDLY	-0.7499	1.0541					-0.7499	1.0541
FNOCLCND	16.4898	13.2291					16.4898	13.2291
IWEEKDLY	4.4648	4.0671					4.4648	4.0671
IDUEDATE	63.6118	9.6131					63.6118	9.6131
INOCLCND	-27.7287	6.5529					-27.7287	6.5529
IAMTSTD	0.0597	0.1718					0.0597	0.1718
FAMTSTD	-0.1085	0.0571					-0.1085	0.0571
FPDEFLT			-11.5148	7.5773	-0.0883	0.2636	-11.6032	7.5652
FAINRATT	2.1165	15.5655					2.1165	15.5655
PVMAIZE	4.6982	2.3373	2.0645	2.6874	0.0417	0.1794	6.8043	2.9309
PPTOB95	-0.5920	0.6393	1.8855	1.4113	0.0336	0.0463	1.3271	1.6583
PSTOB95	6.8688	3.7419					6.8688	3.7419
PCFERT95	4.3571	1.7454					4.3571	1.7454
PSLMZ95	-0.0203	0.1641					-0.0203	0.1641
PSHMZ95	-1.4519	1.1416					-1.4519	1.1416
LANDAREH	1.3184	2.1390	3.6686	3.2649	-0.2465	0.2732	4.7405	3.7103
AGLPAREA	-0.0822	0.0995	0.2731	0.1586	0.0032	0.0066	0.1941	0.1666
TASSETVH	0.0007	0.0006	0.0013	0.0018	0.0000	0.0000	0.0020	0.0022
LDPASSTH	-7.3556	8.5398	1.2315	5.3376	1.1061	1.3246	-37.4811	16.2740
LVPASSTH	20.4063	9.5880	-26.0728	21.5138	1.0771	1.3185	-45.4020	23.0834
YYEDUCH	-1.4005	0.8164	-0.3323	1.2185	-0.0354	0.0638	-1.7682	1.3786
YYEDUCS	-0.3242	0.6678	1.9520	1.3535	-0.0078	0.0412	1.6201	1.3462
POPADL15	-3.0591	2.1362	-5.1890	2.9123	0.0409	0.1085	-8.2073	3.4768
DEPRATIO	18.9232	10.6739	-26.8202	18.6753	0.7248	0.8437	-45.0186	20.2506
AGEH	-0.1029	0.1572	-0.0150	0.2720	0.0096	0.0136	-0.1084	0.2711
MALEHEAD	0.6103	4.8669	-6.1354	7.8765	0.1767	0.3420	-5.3483	9.1147
DISTFA			-2.7742	1.0331	0.0166	0.0412	-2.7576	1.0292
DISTPO			3.6427	1.2170	0.0263	0.0388	3.6690	1.2229
DISTTCEN			-2.7248	1.1966	0.0311	0.0517	-2.6937	1.1873
SOUTH	3.4651	7.3878	-35.6329	23.0927	0.7590	1.1775	-31.4088	21.6019

R-squared = 0.33
F-stat.(all coefficients): $F_{(44,1463)} = 16.40$
F-stat. for the regressors used as instruments in other equations: $F_{(13,1495)} = 1.36$
Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(9)} = 0.58$
Durbin Chi-squared statistics for exogeneity[b]: $x_{(9)} = 1.39$
Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(60)} = 49.98$

[a] The column of direct effects corresponds to the OLS coefficients of the variables included in the equations.
[b] Endogenous regressors: FLOANMAX ILOANMAX IAMTSTD FAMTSTD CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE.
[c] Instruments tested: WMRFC WPROG2 WPAST RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND PVOXEN PVCATL PVGSHP PVCHKD PHVKM PSVKM NCLWATER LATRINE NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVGAPYYP.

Table 6 Informal credit demand equation (ILOANVAL): Matrix of direct and indirect partial effects of selected variables

	Direct effect[a]		Indirect effect through FLOANMAX		Indirect effect through ILOANMAX		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	0.0570	2.9869					0.0570	2.9869
FLOANMAX	-0.0034	0.0019					-0.0034	0.0019
ILOANMAX	0.0680	0.0227					0.0680	0.0227
MRFCH			-0.0677	0.0172			-0.0677	0.0172
MUDZIH			-0.1865	0.0431			-0.1865	0.0431
MUSCOH			-0.1165	0.0338			-0.1165	0.0338
PMERW1H			-0.1960	0.0450			-0.1960	0.0450
PMERW2H			-0.1947	0.0435			-0.1947	0.0435
WMRFC			-10.0494	3.0750			-10.0494	3.0750
WPROG2			-10.1025	3.0391			-10.1025	3.0391
WDPAST			-9.6263	3.0359			-9.6263	3.0359
DP9495	-0.0731	0.4805	0.0376	0.0213	-0.2751	0.2198	-0.3106	0.4886
FWEEKDLY	0.0000	0.0000	0.0813	0.0671	0.1461	0.2931	0.2274	0.2930
FNOCLCND	-0.1278	0.1597					-0.1278	0.1597
IWEEKDLY	-1.2613	0.8090					-1.2613	0.8090
IDUEDATE	6.5236	2.9264					6.5236	2.9264
INOCLCND	1.5294	0.8221					1.5294	0.8221
IAMTSTD	19.4587	2.4285					19.4587	2.4285
FAMTSTD	-0.1046	0.0838					-0.1046	0.0838
FPDEFLT	0.0025	0.0036					0.0025	0.0036
FAINRATT	1.7213	1.8740					1.7213	1.8740
PVMAIZE	0.0001	0.2500	-0.0146	0.0221	-0.0690	0.1594	-0.0834	0.2560
PPTOB95	0.0012	0.0523	-0.0133	0.0131	-0.0556	0.0318	-0.0678	0.0612
PSTOB95	-0.6294	0.5177					-0.6294	0.5177
PCFERT95	-0.0204	0.2696					-0.0204	0.2696
PSLMZ95	0.0012	0.0067					0.0012	0.0067
PSHMZ95	-0.0163	0.1761					-0.0163	0.1761
LANDAREH	-0.1317	0.3408	-0.0259	0.0292	0.4079	0.1765	0.2503	0.3205
AGLPAREA	-0.0193	0.0170	-0.0019	0.0014	-0.0053	0.0059	-0.0265	0.0180
TASSETVH	0.0002	0.0002	-0.0000	0.0000	-0.0000	0.0000	0.0002	0.0002
LDPASSTH	2.3883	1.1688	0.2204	0.1758	-1.8303	0.6484	0.7785	1.1080
LVPASSTH	1.3474	1.2919	0.1840	0.1786	-1.7823	0.6994	-0.2509	1.2871
YYEDUCH	-0.0265	0.1554	0.0023	0.0087	0.0586	0.0500	0.0345	0.1788
YYEDUCS	0.1984	0.1130	-0.0138	0.0104	0.0129	0.0490	0.1975	0.1272
POPADL15	-0.3012	0.2459	0.0366	0.0239	-0.0676	0.1092	-0.3322	0.2702
DEPRATIO	-0.2360	1.3061	0.1893	0.1389	-1.1994	0.6180	-1.2461	1.3453
AGEH	0.0151	0.0228	0.0001	0.0019	-0.0158	0.0133	-0.0006	0.0217
MALEHEAD	0.1279	0.7859	0.0433	0.0596	-0.2924	0.2976	-0.1212	0.8512
DISTFA			0.0196	0.0078	-0.0275	0.0380	-0.0079	0.0384
DISTPO			-0.0257	0.0103	-0.0436	0.0305	-0.0693	0.0317
DISTTCEN			0.0192	0.0144	-0.0515	0.0489	-0.0322	0.0518
SOUTH	2.0511	1.1483	0.2515	0.2050	-1.2559	0.8844	1.0467	1.6091

R-squared = 0.35
F-stat.(all coefficients): $F_{(44,1463)} = 18$
F-stat. for the regressors used as instruments in other equations: $F_{(13,1495)} = 1.14$
Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(9)} = 1.02$
Durbin Chi-squared statistics for exogeneity[c]: $x_{(9)} = 1.12$
Basmann's Chi-squared statistics for the overidentifying restrictions[3]: $x_{(60)} = 102.83$

[a] The column of direct effects corresponds to the OLS coefficients of the variables included in the equations.
[b] Endogenous regressors: FLOANMAX ILOANMAX IAMTSTD FAMTSTD CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE
[c] Instruments tested: WMRFC WPROG2 WPAST RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND PVOXEN PVCATL PVGSHP PVCHKD PHVKM PSVKM NCLWATER LATRINE NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVGAPYYP.

demands for formal credit, but on average would borrow only about half the amount of any increase in their formal credit limits. Therefore, one of the restrictions implied by the practice of using loan size to measure impact is not satisfied.

3. The availability of informal credit (ILOANMAX) has a negative but not statistically significant effect on the demand for formal credit.

4. For all households, the availability of formal credit induces a small and not statistically significant reduction in the demand for informal credit. However, this reduction is much larger for credit program members, with statistically significant differences with noncurrent members ranging from –0.07 MK for MRFC to –0.19 MK for PMERW1 per capita per season. At least for credit program members, one can reject the restriction that formal and informal credits are not (grossly) substitutable.

5. Finally, the interest rate for formal credit (FAINRATT) does not have any statistically significant effect on the demands for formal and informal credits. This suggests that improved access to credit is much more important than its cost for the study households.

Marginal Effect of Access to Formal Credit on Household Incomes

The estimated marginal effects of access to formal and informal credits on crop income, seasonal nonfarm income, and total household annual income are reported in Tables 7, 8, and 9. Note first that the direct marginal effects resulting from mere access to credit, as well as the indirect marginal effects resulting from exercising the option to borrow, are not statistically different from zero for all three types of income. Both indirect effects resulting from the substitutability between formal and informal sources of credit are also not statistically different from zero. As a result, for the average household, the total marginal effects of access to formal credit on all three types of income, although positive and quite sizable (+0.5, +2.6, and +0.4 MK, respectively), are not statistically significantly different from zero. However, 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 credit program members.

As shown in Tables 6-8, this beneficial substitution effect results from the negative correlation between borrowing from informal sources and household crop incomes. The negative correlation applies also to formal credit. Hence, it is the mere act of borrowing, whether from informal or formal sources, that has a negative effect on crop incomes. In contrast, both terms of borrowing are positively correlated with nonfarm income. The beneficial substitution effect is a mere reflection of the fact that the reduced borrowing from informal sources makes informal loans play a lesser role in the negative impact that borrowing in general has on net crop incomes. The negative correlation between

Table 7 Annual income equation (THHINC95): Matrix of direct and indirect partial effects of selected variables

	Direct effect[a]		Indirect effect through FLOANMAX		Indirect effect through ILOANMAX		Indirect effect through FLOANVAL		Indirect effect through ILOANVAL		Indirect effect through Probability choices		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	-7552.4	46,148.7											-7,552.4	46,148.4
FLOANMAX	1.7125	3.3897					-1.3353	1.7707	0.0563	0.0478			0.4334	2.6699
ILOANMAX	6.0580	8.2932					0.1123	0.2287	-1.1095	0.8735			5.0607	8.0223
FLOANVAL	-2.7321	3.5420											-2.7321	3.5420
ILOANVAL	-16.3198	11.4295											-16.3198	11.4295
MRFCH			33.6085	23.8320			-26.2067	13.1621	1.1049	0.3705	-207.450	303.9841	-198.94	301.2462
MUDZIH			92.5909	69.5577			-72.1990	35.0980	3.0441	0.9615	26.8553	702.3767	50.2911	692.0499
MUSCOH			57.8117	52.0858			-45.0795	26.2913	1.9006	0.7409	25.5588	549.5803	40.1916	542.3843
PMERW1H			97.2891	71.7075			-75.8626	36.3650	3.1985	1.0093	27.0664	734.7088	51.6915	723.9371
PMERW2H			96.6358	69.2423			-75.3532	34.8965	3.1770	0.9708	27.0366	704.9439	51.4963	694.6686
WMRFC	-2,657.6	46,814.3	4,988.4	5,757.6			-3,889.8	3,053.5	164.0	75.1			-1,394.9	45,922.0
WPROG	-541.5	47,206.6	5,014.8	5,676.2			-3,910.4	2,995.2	164.8	73.8			727.8	46,361.9
WPAST	395.1	48,921.0	4,778.4	5,757.3			-3,726.0	3,066.4	157.1	73.6			1,604.6	48,159.6
FAINRATT	512.3201	874.0637					-5.7825	63.6319	-28.0907	36.5989			478.4469	846.6599
PVMAIZE	64.0917	202.4048	7.2335	24.0318	-6.1458	23.4056	-18.5904	26.1713	1.3617	4.3108	-1.3801	41.1871	46.5706	192.8925
PPTOB95	156.7981	75.1249	6.6063	18.0323	-4.9574	7.7758	-3.6259	7.8036	1.1060	1.2167	0.8053	15.2987	156.7324	71.2127
LANDAREH	404.4854	242.4733	12.8540	46.1391	36.3444	51.8773	-12.9516	28.2957	-4.0845	5.5917	-1.9882	33.5386	434.6595	218.0339
AGLPAREA	15.2382	14.0111	0.9567	2.4403	-0.4717	1.1602	-0.5302	1.1074	0.4332	0.4342	-0.1826	4.9100	15.4436	11.9138
YYEDUCH	85.5534	76.7510	-1.1642	8.6112	5.2248	10.3604	4.8309	8.1551	-0.5635	2.8733	-0.7670	16.7683	93.1144	75.9134
YYEDUCS	70.3333	69.3534	6.8395	13.7611	1.1490	6.9079	-4.4262	7.2828	-3.2239	2.9348	1.1511	26.8509	71.8228	73.0716
POPADL15	-269.028	256.885	-18.1813	27.2841	-6.0247	16.4731	22.4234	22.7010	5.4210	6.3074	3.7471	161.3987	-261.642	183.623
DEPRATIO	-1,224.9	1,144.0	-93.97	161.06	-106.87	151.9	122.99	128.2	20.33	28.3	-4.081	687.3	-1,286.5	739.6
AGEH	10.1027	14.8259	-0.0526	1.9849	-1.4113	2.3429	0.2961	1.2267	0.0101	0.3391	0.1870	2.6957	9.1320	13.8115
MALEHEAD	-59.4222	448.5843	-21.4970	72.7531	-26.0527	53.4473	14.6123	38.9072	1.9780	12.0697	-20.2237	118.9042	-110.605	444.2657

R-squared = 0.41

F-stat.(all coefficients): $F_{(42,334)} = 5.61$

F-stat. for the regressors used as instruments in other equations: $F_{(19,358)} = 1.30$

Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(12)} = 193.8$

Durbin Chi-squared statistics for exogeneity[b]: $x_{(12)} = 240.4$

Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(48)} = 18.35$

[a] The column of direct effects corresponds to the Two-Stage Least Squares coefficients of the variables included in the equations.

[b] Endogenous regressors: FLOANVAL ILOANVAL CINC94 FLOANMAX ILOANMAX MRFC PROG2 DPAST CDWAGE CWMWAGE CFCWAGE WSL12MHH.

[c] Instruments: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND CDTH3Y CILLAC3Y PHVKM PSVKM NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CVGAPYYP.

Table 8 Crop income equation (CINC95): Matrix of direct and indirect partial effects of selected variables

	Direct effect[a]		Indirect effect through: FLOANMAX		ILOANMAX		FLOANVAL		ILOANVAL		Probability choices		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	5,668.8	21,961.7											5,668.8	21,961.7
FLOANMAX	0.6779	2.3479					-0.1907	1.0624	0.0198	0.0217			0.5071	1.6000
ILOANMAX	5.0084	3.8879					0.0160	0.1262	-0.3908	0.4551			4.6336	3.7975
FLOANVAL	-0.3902	2.0713											-0.3902	2.0713
ILOANVAL	-5.7479	6.2788											-5.7479	6.2788
MRFCH			13.3050	15.1624			-3.7426	6.8114	0.3892	0.1622	-22.3612	142.6544	-12.4096	141.5905
MUDZIH			36.6549	48.8864			10.3107	21.3958	1.0721	0.4860	-66.4203	345.0853	-39.0040	340.3183
MUSCOH			22.8866	35.8089			-6.4378	15.9929	0.6694	0.3620	-40.8944	268.1098	-23.7762	264.8002
PMERW1H			38.5149	49.8833			10.8339	22.0195	1.1265	0.4999	-70.0143	359.2375	-41.2068	354.6772
PMERW2H			38.2563	48.1147			10.7612	21.1909	1.1190	0.4801	-69.5120	345.6370	-40.8980	341.2637
WMRFC	-7,302.4	22,168.6	1,974.8	3,913.5			-555.5	1,751.7	57.7	37.2			-5,825.3	22,048.3
WPROG2	-7,433.4	22,394.0	1,985.2	3,855.1			-558.4	1,724.5	58.0	36.7			-5,948.5	22,304.3
WPAST	-8,476.3	23,203.2	1,891.7	3,859.6			-532.1	1,734.5	55.3	36.7			-7,061.4	23,218.8
FAINRATT	58.1004	518.3794					-0.8258	33.3314	-9.8937	15.2258			47.3809	502.6585
PVMAIZE	76.2780	143.4955	2.8636	16.3850	-5.0810	11.0083	-2.6549	15.2518	0.4796	1.9227	5.2557	20.4854	77.1411	140.0515
PPTOB95	123.4684	43.6626	2.6153	12.3857	-4.0985	3.4505	-0.5178	4.8337	0.3895	0.5175	0.0218	6.6558	121.8788	42.5656
LANDAREH	214.4838	113.2434	5.0886	34.2554	30.0473	23.6012	-1.8496	17.2924	-1.4386	1.9758	-1.5037	15.1473	244.8278	98.9608
AGLPAREA	8.4024	6.9292	0.3787	1.6016	-0.3900	0.5142	-0.0757	0.6673	0.1526	0.1973	-0.6359	2.2259	7.8322	5.9261
YYEDUCH	15.8527	38.7768	-0.4609	6.1185	4.3195	5.5861	0.6899	3.6749	-0.1985	1.3882	1.6335	8.4209	21.8363	38.8014
YYEDUCS	49.3381	37.2588	2.7076	10.9516	0.9499	3.3550	-0.6321	4.0275	-1.1355	1.5530	-4.2999	14.1653	46.9281	38.2710
POPADL15	-36.9193	118.9392	-7.1976	18.2925	-4.9808	8.6492	3.2023	13.3346	1.9093	3.3910	-23.8789	74.9911	-67.8650	84.6205
DEPRATIO	-200.415	511.1822	-37.2018	107.4407	-88.3569	81.6060	17.5651	76.4544	7.1623	13.9748	-92.4618	295.6435	-393.708	355.6040
AGEH	4.6730	6.8759	-0.0208	1.2978	-1.1668	1.1021	0.0423	0.5890	0.0036	0.1550	0.0886	1.3805	3.6199	6.6046
MALEHEAD	45.0110	213.6800	-8.5102	55.2284	-21.5387	30.3052	2.0868	22.9497	0.6967	5.4566	-10.6262	54.1635	7.1193	210.7278

R-squared = 0.48
F-stat.(all coefficients): $F_{(42,334)} = 7.31$
F-stat. for the regressors used as instruments in other equations: $F_{(19,358)} = 1.50$
Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(12)} = 2{,}028.6$
Durbin Chi-squared statistics for exogeneity[b]: $x_{(12)} = 2{,}816.2$
Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(48)} = 11.59$

[a] The column of direct effects corresponds to the Two-Stage Least Squares coefficients of the variables included in the equations.
[b] Endogenous regressors: FLOANVAL ILOANVAL CINC94 FLOANMAX ILOANMAX MRFC PROG2 DPAST CDWAGE CWMWAGE CFCWAGE WSL12MHH.
[c] Instruments: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND CDTH3Y CILLAC3Y PHVKM PSVKM NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CVGAPYYP.

Table 9 Nonfarm seasonal income equation (THHNFINC): Matrix of direct and indirect partial effects of selected variables

Independent variable	Direct effect[a] Estimated coefficient	Direct effect[a] Standard error	Indirect effect through: FLOANMAX Estimated coefficient	FLOANMAX Standard error	ILOANMAX Estimated coefficient	ILOANMAX Standard error	FLOANVAL Estimated coefficient	FLOANVAL Standard error	ILOANVAL Estimated coefficient	ILOANVAL Standard error	Probability choices Estimated coefficient	Probability choices Standard error	Total effect Estimated coefficient	Total effect Standard error
CONSTANT	-2,920.34	19,404.23											-2,920.34	19,404.23
FLOANMAX	0.4578	4.4206					2.2593	3.4814	-0.0780	0.0614			2.6391	3.4024
ILOANMAX	-15.7493	13.7246					-0.1899	0.4905	1.5363	1.2431			-14.4030	12.8875
FLOANVAL	4.6226	6.5655											4.6226	6.5655
ILOANVAL	22.5966	15.3214											22.5966	15.3214
MRFCH			8.9848	28.7866			44.3404	25.4182	-1.5299	0.5782	49.2952	72.3267	101.0905	78.9156
MUDZIH			24.7530	90.2768			122.1569	71.4990	-4.2149	1.2827	-68.6763	434.8680	74.0188	427.2315
MUSCOH			15.4553	65.8514			76.2721	52.8271	-2.6317	0.9642	-46.7539	328.8014	42.3418	323.8395
PMERW1H			26.0091	92.0431			128.3554	74.8116	-4.4287	1.3453	071.4548	443.2866	78.4809	435.2255
PMERW2H			25.8344	88.8814			127.4935	72.0223	-4.3990	1.3004	-71.0717	432.9406	77.8572	424.3577
WMRFC	2,747.1	19,535.3	1,333.6	7,360.9			6,581.3	5,930.3	-227.1	105.2			10.435.0	19,857.4
WPROG2	2,134.7	20,080.4	1,340.6	7,257.9			6,616.2	5,818.0	-228.2	102.3			9,863.3	20.271.0
WPAST	3,583.7	18,081.9	1,277.4	7,333.8			6.304.3	5,863.8	-217.5	102.4			10,947.9	18,490.8
FAINRATT	-43.7343	519.2909					9.7838	109.7342	38.8948	35.5796			4.9442	515.5447
LANDAREH	26.7649	153.0652	3.4364	60.1561	-94.4869	86.9998	21.9135	55.5116	5.6554	5.8953	1.5015	14.6926	-35.2153	138.3163
AGLPAREA	-0.5118	5.9193	0.2558	3.0514	1.2264	1.6560	0.8970	2.2990	-0.5998	0.4885	0.1886	1.8153	1.4562	5.6143
YYEDUCH	3.9859	50.3358	-0.3112	9.4988	-13.5832	17.2357	-8.1736	12.4208	0.7802	3.3265	-0.2270	6.6927	-17.5289	46.7126
YYEDUCS	0.8894	27.4321	1.8285	15.8710	-2.9870	15.4920	7.4889	13.2780	4.4638	3.9187	1.1860	9.6979	12.8696	25.5860
POPADL15	96.8778	121.6048	-4.8605	33.1819	15.6628	30.8281	-37.9392	43.4252	-7.5061	7.9216	5.8635	62.9972	68.0982	102.0560
DEPRATIO	331.9313	503.9407	-25.1223	196.6631	277.8476	273.5825	-208.103	250.7025	-28.156	35.7759	27.524	240.8914	375.921	450.9923
AGEH	-0.7393	6.3068	-0.0141	2.0401	3.6690	3.9147	-0.5009	1.5888	-0.0140	0.3952	-0.1179	1.0155	2.2829	4.8413
MALEHEAD	-14.5879	229.9565	-5.7470	107.9838	67.7308	79.2852	-24.7233	88.2941	-2.7388	14.9004	5.4384	32.7820	25.3723	174.1397

R-squared = 0.16
F-stat.(all coefficients): $F_{(40.1090)} = 5.13$
F-stat. for the regressors used as instruments in other equations: $F_{(18,1113)} = 0.44$
Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(8)} = 676.4$
Durbin Chi-squared statistics for exogeneity[b]: $x_{(8)} = 695.8$
Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(43)} = 12.88$

[a] The column of direct effects corresponds to the Two-Stage Least Squares coefficients of the variables included in the equations.
[b] Endogenous regressors: FLOANVAL ILOANVAL FLOANMAX ILOANMAX MRFC PROG2 DPAST CINC94.
[c] Instruments: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND PVOXEN PVCATL PVGSHP PVCHKD.

borrowing and crop income is not surprising. Indeed, gross margin calculations using on-farm trial data from more than 1,600 sites in Malawi have shown that, even in years of relatively favorable climatic conditions, growing maize (the major crop in Malawi) is barely profitable due to the very low price of maize compared to the very high price of fertilizer (Benson 1997; Msukwa et al. 1994). The very high relative input-output price ratio, combined with the fact that the 1995 harvest was below average and followed a severe drought in 1994, explains why, everything else being equal, smallholder farmers who borrowed to buy inputs experienced lower crop income.[20] Yet, despite the unprofitability of maize, the formal loan demand equation suggests that, on average, once they get access to formal credit, most farmers would not restrain themselves from borrowing. Moreover, they would respond to higher fertilizer prices by increasing their demand for formal loans in order to keep the same level of input use (see Diagne 1997). This type of behavior from smallholder farmers appears irrational unless they expect debt forgiveness or intend to default and use the unprofitability of maize as an excuse (see Msukwa et al. 1994).[21]

For the above reasons, the substitution away from informal sources of credit by credit program members was beneficial for their crop incomes but detrimental for their

[20]Note that, as shown in the direct effect columns, the mere access to credit (formal or informal) is positively correlated with crop income (and with nonfarm income). It is the exercising of the option to borrow by smallholder farmers that negatively affects their net crop income due to the relatively high input-output price ratio.

[21]Note that net crop income includes 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 district surveyed (Mangochi) experienced a complete crop failure (no harvest).

nonfarm incomes. There were no compensating beneficial effects from the increased reliance on formal loans. Consequently, after controlling for all other factors, the incomes of credit program members are still not statistically significantly different from those of noncurrent members. In fact, from the effects of the credit programs—through the choice-based-corrected conditional probability choices (shown in all table columns labeled "Probability choices"), which reflect mostly the self-selection and targeted nature of the programs—one can infer that with or without the direct and indirect effects of access to formal credit, the incomes of credit program members are not statistically significantly different from those of noncurrent members.

Finally, one can see from Table 7 that the two most important determinants of household annual income are landholding size (LANDAREH, +434.7 MK of additional income per capita for every additional hectare of land owned) and the producer price of tobacco (PPTOB95, +156.7 MK of additional income per capita for every MK increase in the producer price). Moreover, the significant marginal effects of these two factors on household income occur as a result of their direct effects on crop income. The indirect effects through household access to credit and borrowing are all statistically insignificant. In contrast, the price of maize, the major food staple and most important crop in terms of area planted in Malawi (PVMAIZE), has no statistically significant direct or indirect effects on household incomes.[22] This suggests that even higher maize prices will fail to increase crop income in Malawi if the 1994 and 1995 climatic conditions continue to

[22]Note that crop income includes nonmarketed crop production valued at market prices.

prevail and smallholders continue to face a severe land constraint. Under the current situation, the adoption of high-value export crops such as tobacco, combined with terms of trade for these products that are favorable to farmers, is more likely to have a bigger impact on per capita incomes in Malawi than a continuous heavy reliance on maize, even with a substantial increase in its producer price.

Marginal Impact of Access to Credit on Household Food Security

Tables 10, 11, and 12 present the results related to the effects of access to formal credit on household food security. The tables show several notable findings. First, access to formal credit has no statistically significant direct effect on per capita household daily food expenditure (Table 10). The indirect effects (through borrowing, substitution, and income) are also all negligible and statistically insignificant. The only exception is the substitution effect for credit program members. However, when all the direct and indirect effects are added there are no statistically significant differences in per capita food expenditure between current and noncurrent members of the credit program.

Second, neither the direct nor the indirect effects on calorie and protein intake of the various channels of access to formal credit (substitution, borrowing, income and food expenditure) are statistically significantly different from zero (Tables 11 and 12). As a

Table 10 Daily food expenditure equation (FOODEXC): Matrix of direct and indirect partial effects of selected variables

	Direct effect[a]		Indirect effect through: FLOANMAX		ILOANMAX		FLOANVAL		ILOANVAL		THHINC95		Probability choices		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	5.5174	4.8133	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.5174	4.8133
FLOANMAX	-0.0003	0.0008	0.0000	0.0000	0.0000	0.0000	0.0004	0.0007	0.0000	0.0000	0.0001	0.0004	0.0000	0.0000	0.0002	0.0006
ILOANMAX	0.0015	0.0014	0.0000	0.0000	0.0000	0.0000	-0.0000	0.0001	-0.0005	0.0004	0.0006	0.0013	0.0000	0.0000	0.0016	0.0018
FLOANVAL	0.0008	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0003	0.0006	0.0000	0.0000	0.0005	0.0014
ILOANVAL	-0.0075	0.0057	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0021	0.0021	0.0000	0.0000	-0.0095	0.0057
THHINC95	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
MRFCH	0.0000	0.0000	-0.0066	0.0055	0.0000	0.0000	0.0080	0.0050	0.0005	0.0002	-0.0251	0.0480	-0.0532	0.0248	-0.0764	0.0519
MUDZIH	0.0000	0.0000	-0.0183	0.0177	0.0000	0.0000	0.0222	0.0145	0.0014	0.0005	0.0063	0.1137	0.0422	0.0741	0.0538	0.1379
MUSCOH	0.0000	0.0000	-0.0114	0.0134	0.0000	0.0000	0.0138	0.0111	0.0009	0.0004	0.0051	0.0888	0.0286	0.0573	0.0369	0.1077
PMERW1H	0.0000	0.0000	-0.0192	0.0184	0.0000	0.0000	0.0233	0.0152	0.0015	0.0005	0.0065	0.1194	0.0441	0.0766	0.0562	0.1441
PMERW2H	0.0000	0.0000	-0.0191	0.0177	0.0000	0.0000	0.0231	0.0145	0.0015	0.0005	0.0065	0.1142	0.0438	0.0739	0.0558	0.1381
WMRFC	4.0373	4.9635	-0.9856	1.4378	0.0000	0.0000	1.1944	1.1930	0.0752	0.0377	-0.1761	7.6577	0.0000	0.0000	4.1451	8.9539
WPROG2	4.7920	4.9462	-0.9908	1.4225	0.0000	0.0000	1.2007	1.1747	0.0756	0.0373	0.0919	7.7558	0.0000	0.0000	5.1693	9.0173
WPAST	5.9827	5.5650	-0.9441	1.4395	0.0000	0.0000	1.1441	1.1858	0.0720	0.0375	0.2025	8.1027	0.0000	0.0000	6.4572	9.6132
FAINRATT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0225	-0.0129	0.0187	0.0604	0.1315	0.0000	0.0000	0.0493	0.1314
PVMAIZE	-0.0712	0.0903	-0.0014	0.0063	-0.0015	0.0051	0.0057	0.0097	0.0006	0.0028	0.0059	0.0342	-0.0041	0.0041	-0.0660	0.0974
PVCASVA	-0.0073	0.0646	0.0014	0.0048	0.0039	0.0050	-0.0019	0.0044	0.0006	0.0023	0.0114	0.0406	0.0000	0.0000	0.0080	0.0755
PVBEANS	0.0734	0.0279	0.0007	0.0018	-0.0025	0.0024	-0.0008	0.0018	0.0010	0.0009	-0.0104	0.0151	0.0000	0.0000	0.0614	0.0334
PVVEGFRT	0.3531	0.0552	-0.0053	0.0134	-0.0040	0.0040	0.0051	0.0098	0.0020	0.0022	0.0158	0.0328	0.0000	0.0000	0.3668	0.0626
PVMEAFSH	0.0113	0.0267	0.0010	0.0036	-0.0018	0.0021	-0.0004	0.0024	0.0013	0.0017	0.0029	0.0206	0.0000	0.0000	0.0143	0.0328
PVDRINK	-0.0008	0.0082	-0.0002	0.0007	-0.0002	0.0004	0.0002	0.0006	-0.0002	0.0004	-0.0033	0.0137	0.0000	0.0000	-0.0045	0.0164
LANDAREH	0.1980	0.0699	-0.0025	0.0142	0.0090	0.0086	0.0040	0.0128	-0.0019	0.0032	0.0549	0.0378	0.0004	0.0037	0.2619	0.0755
POPADL15	-0.8131	0.0835	0.0036	0.0075	-0.0015	0.0037	-0.0069	0.0112	0.0025	0.0034	-0.0330	0.0348	0.0172	0.0145	-0.8312	0.0887
DEPRATIO	-4.3464	0.5818	0.0186	0.0496	-0.0264	0.0304	-0.0378	0.0659	0.0093	0.0154	-0.1624	0.1464	0.0607	0.0621	-4.4844	0.5951
AGEH	0.0065	0.0068	0.0000	0.0005	-0.0003	0.0005	-0.0001	0.0004	0.0000	0.0002	0.0012	0.0023	-0.0000	0.0004	0.0072	0.0071
MALEHEAD	0.3692	0.2404	0.0042	0.0211	-0.0064	0.0112	-0.0045	0.0183	0.0009	0.0079	-0.0140	0.0765	0.0002	0.0110	0.3497	0.2554

R-squared = 0.32
F-stat.(all coefficients): $F_{(37.1093)} = 13.64$
F-stat. for the regressors used as instruments in other equations: $F_{(9,1122)} = 1.62$
Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(14)} = 1.80$
Durbin Chi-squared statistics for exogeneity[b]: $x_{(14)} = 1.78$
Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(49)} = 59.92$

[a] The column of direct effects corresponds to the Ordinary Least Squares coefficients of the variables included in the equations.
[b] Endogenous regressors: FLOANVAL ILOANVAL THHINC95 FLOANMAX ILOANMAX MRFC PROG2 DPAST CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE SINCS95.
[c] Instruments: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND FAINRATT PPTOB95 PSTOB95 PCFERT95 PSLMZ95 PSHMZ95 PVOXEN PVCATL PVGSHP PVCHKD NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVG9495P CVGAPYYP.

Table 11 Daily calorie intake equation (CALORYC): Matrix of direct and indirect partial effects of selected variables

			Indirect effect through																	
	Direct effect[a]		FLOANMAX		ILOANMAX		FLOANVAL		ILOANVAL		THHINC95		FOODEXC		Probability choices		Total effect	
Independent variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	1,937.02	1,048.45	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1,937.02	1,048.45
FLOANMAX	0.2395	0.1495	0.0000	0.0000	0.0000	0.0000	-0.1553	0.1220	0.0049	0.0075	0.0073	0.0641	0.0298	0.1195	0.0000	0.0000	0.1263	0.1870
ILOANMAX	-0.0621	0.3900	0.0000	0.0000	0.0000	0.0000	0.0131	0.0200	-0.0974	0.1300	0.0853	0.2685	0.3119	0.3485	0.0000	0.0000	0.2508	0.6678
FLOANVAL	-0.3177	0.2640	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0461	0.0932	0.0968	0.2747	0.0000	0.0000	-0.2670	0.4087
ILOANVAL	-1.4325	1.9838	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.2751	0.3781	-1.8687	1.1223	0.0000	0.0000	-3.5763	2.4391
THHINC95	0.0169	0.0179	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0247	0.0123	0.0000	0.0000	0.0416	0.0198
FOODEXC	195.9134	14.0300	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	195.9134	14.0300
MRFCH	0.0000	0.0000	4.7011	1.1077	0.0000	0.0000	-3.0476	0.9171	0.0970	0.0547	-3.3540	6.7474	-14.9710	10.1916	-7.7437	6.3301	-24.3182	15.8915
MUDZIH	0.0000	0.0000	12.9514	3.7507	0.0000	0.0000	-8.3962	2.8636	0.2672	0.1664	0.8479	18.8042	10.5348	26.7004	-6.8448	18.2449	9.3602	42.8221
MUSCOH	0.0000	0.0000	8.0866	2.8922	0.0000	0.0000	-5.2424	2.1834	0.1668	0.1292	0.6776	15.5823	7.2350	20.8735	-4.2715	14.2540	6.6520	34.3723
PMERW1H	0.0000	0.0000	13.6086	3.9402	0.0000	0.0000	-8.8222	2.9652	0.2808	0.1738	0.8715	19.3594	11.0068	27.9099	-7.1443	18.8800	9.8011	44.5487
PMERW2H	0.0000	0.0000	13.5172	3.8016	0.0000	0.0000	-8.7630	2.8751	0.2789	0.1680	0.8682	18.8562	10.9408	26.7660	-7.1035	18.1871	9.7385	43.0396
WMRFC	753.484	1,117.798	697.7762	263.4124	0.0000	0.0000	-452.355	204.5549	14.3959	12.8061	-23.5174	1,240.646	812.0895	1,743.183	0.0000	0.0000	1,801.873	2,796.261
WPROG2	833.522	1,120.218	701.4679	263.2344	0.0000	0.0000	-454.749	203.2316	14.4720	12.6689	12.2701	1,264.627	1,012.728	1,758.306	0.0000	0.0000	2,119.712	2,822.899
WPAST	1,266.95	1,224.561	668.4025	262.0325	0.0000	0.0000	-433.313	203.0325	13.7899	12.6112	27.0523	1,315.589	1,265.056	1,877.552	0.0000	0.0000	2,807.943	2,997.378
FAINRATT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.6725	7.8214	-2.4657	4.8241	8.0661	24.4193	9.6568	25.4485	0.0000	0.0000	14.5847	44.3950
PVMAIZE	-123.422	23.9276	1.0118	1.4970	0.0630	1.0657	-2.1619	1.9707	0.1195	0.6106	0.7851	5.2811	-12.9226	19.0735	-0.8120	1.0546	-137.339	28.3977
PVCASVA	-55.8158	14.6715	-0.09893	1.1714	-0.1618	1.0216	0.7331	1.0266	0.1112	0.5387	1.5236	6.8858	1.5715	14.6747	0.0000	0.0000	-53.0276	22.4637
PVBEANS	-18.9885	6.7343	-0.4997	0.5172	0.1050	0.6036	0.2942	0.4817	0.1888	0.2801	-1.3924	2.1735	12.0264	6.5578	0.0000	0.0000	-8.2662	10.3826
PVVEGFRT	-37.8718	18.0676	3.7612	2.8305	0.1650	1.0234	-1.9387	2.3998	0.3912	0.7650	2.1140	4.4157	71.8666	13.7271	0.0000	0.0000	38.4874	22.0776
PVMEAFSH	-6.6562	7.0132	-0.6903	0.7057	0.0734	0.4510	0.1660	0.5270	0.2537	0.4510	0.3861	2.9983	2.7948	6.3651	0.0000	0.0000	-3.6725	10.5964
PVDRINK	4.0941	2.1142	0.1246	0.1526	0.0078	0.0761	-0.0807	0.1282	-0.0434	0.0979	-0.4403	2.0669	-0.8855	3.1757	0.0000	0.0000	2.7766	5.0207
LANDAREH	-27.3749	15.8647	1.7980	2.4239	-0.3723	2.3598	-1.5062	2.3434	-0.3585	0.8475	7.3279	8.1515	51.3041	15.6957	0.2077	0.9857	31.0258	23.2492
POPADL15	-167.215	17.3910	-2.5432	1.9017	0.0617	0.6862	2.6077	2.1122	0.4758	0.9755	-4.4110	6.1550	-162.846	20.1677	2.9799	3.3226	-330.890	24.7581
DEPRATIO	-811.307	110.3291	-13.1446	9.5763	1.0948	7.3671	14.3035	10.1402	1.7850	4.0843	-21.6899	22.9986	-878.554	130.9740	10.7981	14.9665	-1,696.71	165.8463
AGEH	3.7934	1.7908	-0.0074	0.1412	0.0145	0.1231	0.0344	0.1200	0.0009	0.0483	0.1540	0.4261	1.4198	1.3673	-0.0117	0.0895	5.3979	2.4247
MALEHEAD	21.7985	68.3557	-3.0069	4.9294	0.2669	2.3507	1.6993	4.0974	0.1736	2.1342	-1.8647	12.2920	68.5142	50.3749	-0.1028	2.7056	87.4781	91.4149

R-squared = 0.26

F-stat.(all coefficients): $F_{(38.1092)} = 10.19$

F-stat. for the regressors used as instruments in other equations: $F_{(9,1122)} = 5.03$

Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(15)} = 1.18$

Durbin Chi-squared statistics for exogeneity[b]: $x_{(15)} = 1.85$

Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(49)} = 40.97$

[a] The column of direct effects corresponds to the Ordinary Least Squares coefficients of the variables included in the equations.

[b] Endogenous regressors: FLOANVAL ILOANVAL THHINC95 FOODEXC FLOANMAX ILOANMAX MRFC PROG2 DPAST CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE SINCS95.

[c] Instruments: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND FAINRATT PPTOB95 PSTOB95 PCFERT95 PSLMZ95 PSHMZ95 PVOXEN PVCATL PVGSHP PVCHKD NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVG9495P CVGAPYYP.

Table 12 Daily protein intake equation (PROTEINC): Matrix of direct and indirect partial effects of selected variables

Independent variable	Direct effect[a]		Indirect effect through: FLOANMAX		ILOANMAX		FLOANVAL		ILOANVAL		THHINC95		FOODEXC		Probability choices		Total effect	
	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error	Estimated coefficient	Standard error
CONSTANT	-92.4470	166.0262	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-92.4470	166.0262
FLOANMAX	0.1074	0.1318	0.0000	0.0000	0.0000	0.0000	-0.0815	0.1040	0.0000	0.0014	-0.0032	0.0171	0.0019	0.0067	0.0000	0.0000	0.0246	0.0483
ILOANMAX	-0.1451	0.3020	0.0000	0.0000	0.0000	0.0000	0.0069	0.0123	-0.0003	0.0273	-0.0374	0.0523	0.0194	0.0206	0.0000	0.0000	-0.1566	0.2827
FLOANVAL	-0.1668	0.1911	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0202	0.0239	0.0060	0.0163	0.0000	0.0000	-0.1406	0.1896
ILOANVAL	-0.0048	0.3772	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1206	0.0999	-0.1164	0.0806	0.0000	0.0000	-0.0006	0.3664
THHINC95	-0.0074	0.0052	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0010	0.0000	0.0000	-0.0058	0.0050
FOODEXC	12.2026	3.7080	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	12.2026	3.7080
MRFCH	0.0000	0.0000	2.1081	0.9818	0.0000	0.0000	-1.5997	0.7761	0.0003	0.0105	1.4701	1.8854	-0.9325	0.6586	2.0373	1.3134	3.0836	2.0212
MUDZIH	0.0000	0.0000	5.8077	2.4690	0.0000	0.0000	-4.4071	1.8546	0.0009	0.0292	-0.3716	4.2578	0.6562	1.6303	2.4327	3.0374	4.1187	4.7127
MUSCOH	0.0000	0.0000	3.6262	1.8653	0.0000	0.0000	-2.7517	1.3732	0.0006	0.0223	-0.2970	3.2499	0.4506	1.2867	1.4624	2.3773	2.4911	3.6557
PMERW1H	0.0000	0.0000	6.1024	2.5702	0.0000	0.0000	-4.6308	1.8867	0.0009	0.0305	-0.3820	4.4027	0.6856	1.7208	2.5658	3.1390	4.3420	4.8792
PMERW2H	0.0000	0.0000	6.0614	2.4629	0.0000	0.0000	-4.5997	1.8134	0.0009	0.0294	-0.3805	4.2053	0.6815	1.6392	2.5473	3.0391	4.3109	4.6910
WMRFC	209.923	166.9032	312.8968	216.5914	0.0000	0.0000	-237.440	164.5999	0.0485	2.4180	10.3078	291.6821	50.5814	108.1826	0.0000	0.0000	346.3178	323.9520
WPROG2	200.857	164.3553	314.5522	212.8646	0.0000	0.0000	-238.696	161.0225	0.0488	2.3687	-5.3781	293.3134	63.0784	109.2879	0.0000	0.0000	334.4615	322.3594
WPAST	207.591	189.8214	299.7250	217.8854	0.0000	0.0000	-227.445	164.9746	0.0465	2.3653	-11.8572	305.6325	78.7947	116.9142	0.0000	0.0000	346.8549	351.5252
FAINRATT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.3530	2.7272	-0.0083	0.8177	-3.5354	5.8876	0.6015	1.5405	0.0000	0.0000	-3.2952	5.5898
PVMAIZE	-4.1229	2.1401	0.4537	1.0392	0.1472	0.6804	-1.1348	1.4873	0.0004	0.0974	-0.3441	1.4950	-0.8049	1.0942	-0.1224	0.1701	-5.9278	2.5010
PVCASVA	-4.9982	2.6720	-0.4436	0.7307	-0.3783	0.8718	0.3848	0.5831	0.0004	0.0868	-0.6678	1.4249	0.0979	0.8443	0.0000	0.0000	-6.0049	3.0035
PVBEANS	-1.4044	0.8068	-0.2241	0.3538	0.2455	0.5029	0.1544	0.2571	0.0006	0.0491	0.6103	0.6319	0.7491	0.4401	0.0000	0.0000	0.1314	0.8806
PVVEGFRT	-2.5892	2.4929	1.6866	2.0296	0.3858	0.8805	-1.0176	1.2112	0.0013	0.1418	-0.9266	1.2943	4.4762	1.6048	0.0000	0.0000	2.0164	2.2130
PVMEAFSH	-0.9739	0.7201	-0.3095	0.4051	0.1717	0.3460	0.0871	0.2346	0.0009	0.0838	-0.1692	0.7708	0.1741	0.3838	0.0000	0.0000	-1.0189	1.0014
PVDRINK	-0.1183	0.2385	0.0559	0.0995	0.0182	0.0562	-0.0424	0.0671	-0.0001	0.0158	0.1930	0.6127	-0.0552	0.1906	0.0000	0.0000	0.0511	0.5713
LANDAREH	0.9278	2.8644	0.8063	1.6800	-0.8707	1.9410	-0.7906	1.4426	-0.0012	0.1376	-3.2118	2.1744	3.1955	1.3267	0.0465	0.1558	0.1017	1.8728
POPADL15	-5.2861	3.2965	-1.1404	0.9289	0.1443	0.5373	1.3688	1.2657	0.0016	0.1783	1.9334	1.7234	-10.1430	3.1868	0.6054	0.5117	-12.5160	3.1464
DEPRATIO	-34.7834	17.0598	-5.8943	6.2932	2.5604	6.0732	7.5079	7.2697	0.0060	0.7371	9.5068	6.7419	-54.7212	17.3090	2.4638	2.2642	-73.3541	15.5035
AGEH	0.1257	0.1949	-0.0033	0.0732	0.0338	0.0904	0.0181	0.0521	0.0000	0.0072	-0.0675	0.0962	0.0884	0.0857	-0.0031	0.0143	0.1921	0.2054
MALEHEAD	-4.6434	8.7951	-1.3484	3.5306	0.6241	1.8751	0.8920	2.6718	0.0006	0.3268	0.8173	2.8234	4.2674	3.0297	0.4402	0.4956	1.0498	8.3412

R-squared = 0.21

F-stat.(all coefficients): $F_{(38.1092)} = 7.72$

F-stat. for the regressors used as instruments in other equations: $F_{(9,1122)} = 3.35$

Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(15)} = 16.44$

Durbin Chi-squared statistics for exogeneity[b]: $x_{(15)} = 24.89$

Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(49)} = 18.78$

[a] The column of direct effects corresponds to the Two-Stage Least Squares coefficients of the variables included in the equations.

[b] Endogenous regressors: FLOANVAL ILOANVAL THHINC95 FOODEXC FLOANMAX ILOANMAX MRFC PROG2 DPAST CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE SINCS95.

[c] Instruments: RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND FAINRATT PPTOB95 PSTOB95 PCFERT95 PSLMZ95 PSHMZ95 PVOXEN PVCATL PVGSHP PVCHKD NCLWATER NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVG9495P CVGAPYYP.

result, the overall marginal effect of access to formal credit on the food security of the *average* household is not statistically significantly different from zero. However, everything else being equal, mere access to formal credit has significantly higher effects on food security for credit program members as compared to noncurrent members. Likewise, the substitution away from informal sources of credit appears to significantly improve the protein intake of credit program members as compared to noncurrent members. But, when credit program members exercise the option to borrow from the formal sector, they end up being significantly worse off. Again, as with income, the mere act of borrowing (not just from formal sources) is negatively correlated with both calorie and protein intake. This explains why the reduction in borrowing from informal sources has a positive impact on household food security, while increased borrowing from formal sources has the opposite effect.[23] When all the direct and indirect effects of membership in credit programs are added (including the effects of self-selection and targeted nature of the programs), there appear to be no statistically significant differences between the level of food security of credit program members and that of noncurrent members. There are two possible explanations for the negative correlation between borrowing and food security as measured by calorie and protein intake. The first explanation arises from the negative correlation between borrowing and crop income. Everything else being equal, this negative correlation should lead to lower calorie intake, especially if smallholders have to repay the loan. The second possible explanation is that if the loan granted is not enough

[23]Tables 10-12 show that mere access to formal credit, as measured by the credit limit variable FLOANMAX, has direct positive effects on both calorie and protein intake, although the effects are not statistically significant.

for the intended investment, the household may reduce food consumption in order to make up for the shortfall.

Third, Tables 11 and 12 show that, as expected, the most important determinant of household food security is per capita daily food expenditure (FOODEXC, 195.9 and 12.2 for calorie and protein intakes, respectively). Once daily per capita food expenditure is controlled for, the only other variables with important and statistically significant overall effects on per capita daily calorie and protein intakes are the price of maize (PVMAIZE, –137 and –5.9, respectively) and the price of cassava (PVCASVA, –53 and –6, respectively). Furthermore, these negative effects of maize and cassava prices are due mostly to their direct negative impact on both daily calorie and protein intakes. The indirect effects through the various channels (access to credit, borrowing, income, and food expenditure) are not statistically different from zero. Maize and cassava are the two most important food staples in Malawi and together they occupy more than 80 percent of the country's cultivated land. Therefore, because of the nonseparability between the food consumption and production decisions of agricultural households (Singh, Squire, and Strauss 1986), one should expect maize and cassava prices to have direct effects on calorie and protein intakes in addition to their indirect effects through the household food budget. The prices of beans (PVBEANS) and vegetables and fruits (PVVGFRT) also have statistically significant direct negative effects on calorie and protein intakes for similar reasons. For the same inseparability reasons, total household income should also have a direct positive effect on both calorie and protein intakes. However, only its indirect effects through the household food budget are statistically significant. Furthermore, its overall total effect is statistically significant only for calorie intake. Finally, a larger household adult population size and higher dependency ratios have negative and statistically significant effects on household food security.

Marginal Effect 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 13 and 14. The weight-for-age Z-score measures short-term or acute malnutrition, while the height-for-age Z-score measures chronic malnutrition. The results are broadly in agreement with the ones for food security, except for a few 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, everything else being equal, mere access to formal credit appears to induce statistically significant positive effects (the more positive the better) on the nutrition of preschoolers in credit program member households as compared to those in noncurrent member households. (The only exceptions are MRFC member households.) When the option to borrow is exercised, preschoolers in credit program member households (except the ones in MRFC households) end up having significantly worse chronic malnutrition, compared to those in noncurrent member households. Furthermore,

Table 13 Weight-for-age equation (WFAGEZ): Matrix of direct and indirect partial effects of selected variables

			Indirect effect through																	
	Direct effect[a]		FLOANMAX		ILOANMAX		FLOANVAL		ILOANVAL		THHINC95		CalorieC		PORTEINC		Probability choices		Total effect	
Independent variable	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Esti. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error
CONSTANT	-1.1854	8.7565	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.1854	8.7565
FLOANMAX	-0.0022	0.0040	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0034	-0.0001	0.0001	0.0001	0.0006	0.0000	0.0002	0.0001	0.0007	0.0000	0.0000	0.0024	0.0025
ILOANMAX	-0.0108	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0018	0.0015	0.0008	0.0023	0.0000	0.0005	0.0004	0.,0047	0.0000	0.0000	-0.0077	0.0086
FLOANVAL	-0.0002	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0004	0.0008	-0.0000	0.0003	0.0003	0.0026	0.0000	0.0000	-0.0003	0.0076
ILOANVAL	0.0264	0.0201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0027	0.0034	-0.0002	0.0030	0.0000	0.0049	0.0000	0.0000	0.0236	0.0196
THHINC95	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0002	0.0002
CalorieC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0096	0.1377	-0.0292	0.1463	0.0000	0.0000	-0.0196	0.0944
PROTEINC	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007
MRFCH	-0.0024	0.0129	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0024	0.0129
MUDZIH	0.0000	0.0000	-0.0435	0.0274	0.0000	0.0000	-0.0020	0.0247	-0.0018	0.0005	-0.0324	0.0606	-0.0012	0.0144	-0.0074	0.0282	-0.0225	0.0572	-0.1108	0.0900
MUSCOH	0.0000	0.0000	-0.1199	0.0818	0.0000	0.0000	-0.0056	0.0691	-0.0049	0.0016	0.0082	0.1549	0.0005	0.0295	-0.0099	0.0768	0.0298	0.1392	-0.1018	0.1951
PMERW1H	0.0000	0.0000	-0.0749	0.0652	0.0000	0.0000	-0.0035	0.0550	-0.0031	0.0012	0.0065	0.1250	0.0003	0.0232	-0.0060	0.0603	0.0199	0.1118	-0.0607	0.1570
PMERW2H	0.0000	0.0000	-0.1260	0.0867	0.0000	0.0000	-0.0059	0.0732	-0.0052	0.0016	0.0084	0.1614	0.0005	0.0304	-0.0104	0.0789	0.0312	0.1454	-0.1074	0.2024
WMRFC	0.0000	0.0000	-0.1251	0.0831	0.0000	0.0000	-0.0058	0.0701	-0.0051	0.0016	0.0084	0.1556	0.0005	0.0293	-0.0103	0.0762	0.0310	0.1403	-0.1066	0.1953
WPROG2	1.2571	8.6045	-6.4594	6.8822	0.0000	0.0000	-0.3018	5.9161	-0.2656	0.1182	-0.2270	10.2426	0.0883	2.0823	-0.8296	5.3243	0.0000	0.0000	-6.7380	13.6900
WPAST	1.5854	8.5201	-6.4936	6.7912	0.0000	0.0000	-0.3034	5.8175	-0.2670	0.1172	0.1185	10.4367	0.1039	2.2038	-0.8012	5.2976	0.0000	0.0000	-6.0574	13.7584
	1.7396	9.1971	-6.1875	6.8691	0.0000	0.0000	-0.2891	5.9042	-0.2544	0.1166	0.2612	10.9360	0.1377	2.5604	-0.8309	5.6527	0.0000	0.0000	-5.4235	15.0258

R-squared = 0.13

F-stat.(all coefficients): $F_{(38.579)} = 2.34$

Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(19)} = 29.65$

Durbin Chi-squared statistics for exogeneity[b]: $x_{(19)} = 29.95$

Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(51)} = 24.66$

Note: Est. coeffi. = estimated coefficient.

[a] The column of direct effects corresponds to the Two-Stage Least Squares coefficients of the variables included in the equations.

[b] Endogenous regressors: FLOANVAL ILOANVAL THHINC95 CALORYC PROTEINC FLOANMAX ILOANMAX MRFC PROG2 DPAST CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE SINCS95 CDTH3Y CILLAC3Y WSL12MHH.

[c] Instruments: PVMAIZE PVCASVA PVBEANS PVVEGFRT PVMEAFSH PVDRINK PVOTHER RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND FAINRATT PPTOB95 PSTOB95 PCFERT95 PSLMZ95 PSHMZ95 PVOXEN PVCATL PVGSHP PVCHKD NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVG9495P CVGAPYYP.

Table 14 Height-for-age equation (HFAGEZ): Matrix of direct and indirect partial effects of selected variables

Independent variable	Direct effect[a]		Indirect effect through: FLOANMAX		ILOANMAX		FLOANVAL		ILOANVAL		THHINC95		CalorieC		PORTEINC		Probability choices		Total effect	
	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Esti. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error	Est. coeffi.	Standard error
CONSTANT	-19.6124	12.0794	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-19.6124	12.0794
FLOANMAX	0.0088	0.0063	0.0000	0.0000	0.0000	0.0000	-0.0086	0.0054	0.0000	0.0001	0.0000	0.0009	0.0003	0.0003	-0.0005	0.0011	0.0000	0.0000	0.0000	0.0033
ILOANMAX	0.0114	0.0106	0.0000	0.0000	0.0000	0.0000	0.0007	0.0007	-0.0006	0.0016	0.0002	0.0031	0.0005	0.0009	0.0035	0.0066	0.0000	0.0000	0.0158	0.0118
FLOANVAL	-0.0175	0.0109	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0014	-0.0006	0.0005	0.0031	0.0042	0.0000	0.0000	-0.0150	0.0118
ILOANVAL	-0.0084	0.0227	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0007	0.0058	-0.0074	0.0056	0.0000	0.0087	0.0000	0.0000	-0.0164	0.0228
THHINC95	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0003	0.0003
CalorieC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4059	0.2185	-0.2726	0.2119	0.0000	0.0000	0.1334	0.1433
PROTEINC	0.0021	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0011
MRFCH	-0.0223	0.0185	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0223	0.0185
MUDZIH	0.0000	0.0000	0.1726	0.0387	0.0000	0.0000	-0.1680	0.0332	0.0006	0.0006	-0.0083	0.1037	-0.0504	0.0258	-0.0689	0.0438	0.0448	0.0827	-0.0777	0.1304
MUSCOH	0.0000	0.0000	0.4754	0.1392	0.0000	0.0000	-0.4629	0.1191	0.0016	0.0015	0.0021	0.2056	0.0194	0.0456	-0.0920	0.1227	0.0432	0.1933	-0.0133	0.2852
PMERW1H	0.0000	0.0000	0.2968	0.1079	0.0000	0.0000	-0.2890	0.0912	0.0010	0.0012	0.0017	0.1628	0.0138	0.0364	-0.0556	0.0945	0.0228	0.1528	-0.0087	0.2279
PMERW2H	0.0000	0.0000	0.4995	0.1474	0.0000	0.0000	-0.4864	0.1262	0.0016	0.0016	0.0021	0.2155	0.0203	0.0472	-0.0970	0.1274	0.0464	0.1996	-0.0134	0.2972
WMRFC	0.0000	0.0000	0.4961	0.1414	0.0000	0.0000	-0.4831	0.1210	0.0016	0.0016	0.0021	0.2063	0.0202	0.0458	-0.0963	0.1232	0.0459	0.1931	-0.0134	0.2858
WPROG2	14.7045	11.8173	25.6118	10.9543	0.0000	0.0000	-24.9390	9.4233	0.0839	0.1287	-0.0579	15.4291	3.7335	3.5840	-7.7360	8.7209	0.0000	0.0000	11.4008	18.7896
WPAST	14.5745	11.5263	25.7473	10.8101	0.0000	0.0000	-25.0709	9.2941	0.0844	0.1263	0.0302	15.3982	4.3920	3.7925	-7.4711	8.7532	0.0000	0.0000	12.2864	18.7082
	17.7437	12.6775	24.5336	10.7491	0.0000	0.0000	-23.8891	9.2587	0.0804	0.1272	0.0666	16.3630	5.8180	4.4831	-7.7480	9.3107	0.0000	0.0000	16.6053	20.3844

R-squared = 0.11

F-stat.(all coefficients): $F_{(38.579)} = 1.90$

Wu-Hausman Chi-squared statistics for exogeneity[b]: $x_{(19)} = 225.50$

Durbin Chi-squared statistics for exogeneity[b]: $x_{(19)} = 326.03$

Basmann's Chi-squared statistics for the overidentifying restrictions[c]: $x_{(51)} = 33.58$

Note: Est. coeffi. = estimated coefficient.

[a] The column of direct effects corresponds to the Two-Stage Least Squares coefficients of the variables included in the equations.

[b] Endogenous regressors: FLOANVAL ILOANVAL THHINC95 CALORYC PROTEINC FLOANMAX ILOANMAX MRFC PROG2 DPAST CINC94 FGIFTRV CDWAGE CWMWAGE CFCWAGE SINCS95 CDTH3Y CILLAC3Y WSL12MHH.

[c] Instruments: PVMAIZE PVCASVA PVBEANS PVVEGFRT PVMEAFSH PVDRINK PVOTHER RELALEND SHTRADEL FARMLEND MALELEND RICHLEND SVLGLEND NGOLEND FAINRATT PPTOB95 PSTOB95 PCFERT95 PSLMZ95 PSHMZ95 PVOXEN PVCATL PVGSHP PVCHKD NWLSBUY DISTFA DISTPO DISTPSCH DISTTCEN CROPRISK CVG9495P CVGAPYYP.

because of the positive correlation between informal borrowing and short-term nutrition levels, credit program members' substitution away from informal credit leads to a significant deterioration in the short-term nutritional status of their preschoolers, compared to the status of noncurrent member households.[24] Finally, as with food security, when all the direct and indirect effects of membership in credit programs are added (including the effects of self-selection and the targeted nature of the programs), there appears to be no statistically significant differences in the acute and chronic malnutrition of preschoolers in credit program member and noncurrent member households.

5. CONCLUSION

The estimated marginal effects of either the amount of credit received or membership in a credit program are not valid measures of the effect of access to credit on household welfare. This paper has shown how the concept of maximum credit provides an alternative and more satisfactory framework for measuring the impact of access to credit. Various direct and indirect effects on household incomes, food security, and nutritional status of preschoolers have been estimated by applying the maximum credit framework to data collected in Malawi. The main findings show that, while access to formal credit enables households to reduce their borrowing from informal sources and thereby experience marginally beneficial effects on household annual income, these effects are too small to cause any significant difference between the per capita incomes, food

[24]However, given the reduced form nature of the estimated equations, one must be cautious with the causal interpretations given here. The negative correlation can be consistent with households borrowing more to take care of their children, when the nutritional status of the children is deteriorating.

security, and nutritional status of credit program members and those of noncurrent members. Furthermore, this beneficial substitution effect reflects only the fact that reduced borrowing from informal sources makes informal loans play a lesser role in the negative effect that borrowing (from formal or informal sources) has on net crop incomes. The marginal effects on household farm and nonfarm incomes that result from mere access to formal credit are positive and quite sizable, but not statistically significantly different from zero.

That credit program members have not yet benefitted from access to formal credit may be due to the fact that they have not been members for a long enough period.[25] The below-average 1995 harvest that followed a severe drought in 1994 should also be kept in mind. However, the most likely cause of the lack of positive effect of access to formal credit on household welfare is the unfavorable terms of trade for the farm products of smallholders. Indeed, gross margin calculations using on-farm trial data have shown that even in relatively favorable climatic conditions, growing maize is barely profitable due to the very low relative price of maize and fertilizer (Benson 1997; and Msukwa et al. 1994). 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." Yet, despite the unprofitability of maize, the formal loan demand equation suggests that, on average, once they get access to formal credit, most farmers would not restrain themselves from borrowing. However, the finding that the price of tobacco has a significant and

[25]The average length of membership at the time of the survey was less than 3 years.

much bigger impact on income than the price of maize, suggests that, instead of maize, farmers should be devoting more of their scarce resources to tobacco if they want to see a significant increase in their incomes.

Land scarcity remains the most constraining factor for increasing per capita household incomes in Malawi. Access to formal credit may not have had positive effects because of the severe land constraint. The main conclusion drawn from this analysis is 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, policy reforms should emphasize a more equitable land distribution to ease the land constraints facing smallholder farmers, and should encourage an efficient and sustainable use of existing cultivable land. However, one must recognize the possible limitation of land reforms in alleviating the land constraint. More than 80 percent of the cultivable land in Malawi is already being farmed under the customary tenure system by smallholder households with an average landholding of 1.1 hectares. Furthermore, 55 percent of these farms are less than 1 hectare each and 95 percent are less than 3 hectares (World Bank 1987).[26] Therefore, it is doubtful that land reform can significantly alleviate the land constraint facing the smallholder, because reform would be limited to the remaining 20 percent of cultivable land in the hands of large estate holders. Given the limited scope for land reform, policy reforms should put more emphasis on promoting the adoption of high-value export crops such as tobacco, and work toward terms of trade for

[26]The average household size in the sample is 5.

these products that are favorable to farmers. Such policy reforms are more likely to have a bigger effect on rural poverty and food insecurity in Malawi than a continuous heavy reliance on maize, even with a substantial increase in its producer price.

APPENDIX 1

Correcting for the Effects of Choice-Based Sampling

To consistently estimate the parameters of any of the equations ([1] through [5]) in the system, one needs to derive the probability density and conditional means of the distribution of y|x under choice-based sampling. Although the case treated in the literature on estimation under choice-based sampling occurs when the same dependent variable *y* is used as a stratifying variable (Manski and McFadden 1981; Amemiya 1985; Hausman and Wise 1981; Cosslett 1981, 1993), the same method can be used to derive consistent estimators of the population parameters when the endogenous stratifying variable is other than *y* (the membership status variable in this case). If $j=1,\dots,J$ indexes are the J alternative choices defining the strata, then under choice-based sampling, the conditional probability density and mean of $y|x$ are given, respectively, by[27]

$$\tilde{p}(y|x) = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j|x) p(y|x,j)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j|x)} \qquad \textbf{(9)}$$

and

[27]The derivation of equations (8) and (9) follows from the sampling procedure and Bayes's rule.

$$\tilde{E}(y|x) \equiv \int y\tilde{p}(y|x)dy = \frac{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j|x) E(y|x,j)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j|x)} . \qquad \textbf{(10)}$$

If we define the choice-based-corrected conditional probability choices as

$$w_j \equiv \frac{\frac{H(j)}{Q(j)} p(j|x)}{\sum_{j=1}^{J} \frac{H(j)}{Q(j)} p(j|x)} \quad j=1,\ldots,J , \qquad \textbf{(11)}$$

then the conditional mean of $y|x$ under choice-based sampling can be written as a weighted sum of the population conditional means $E(y|x,j)$, where the weights are precisely the choice-based-corrected conditional probability choices. That is:

$$\tilde{E}(y|x) = \sum_{j=1}^{J} w_j E(y|x,j) . \qquad \textbf{(12)}$$

Because the population ratios in this study, $Q(j)$, $j=1,\ldots,J$, are known (they are obtained from the village census done prior to the survey), one can use equation (9) to jointly and consistently estimate, by maximum likelihood methods, the population parameters of the distribution of $y|x,j$ and the conditional probability choices (after specifying a multinomial probit or logit model for $p(j|x)$). Except for the additional terms involving the conditional density of $y|x,j$, the likelihood function resulting from equation

(9) is the same as the one for the Manski-McFadden (1981) choice-based sampling estimator (see also Amemiya 1985, 330).[28] However, as described in this paper, a two-stage estimation method similar to Heckman's two-step procedure for Tobit models is used here.

The explicit form of equation (12) from equations (1) through (5) is derived by writing the population conditional means $E(y|x,j)$ as

$$E(y|x,j) = \alpha x + \beta_j z(j) \quad j=1,\ldots,J, \tag{13}$$

where $z(j)$ is a vector of alternative-specific regressors and α and β_j are the parameters to be estimated.[29] Hence, equation (12) becomes

$$\tilde{E}(y|x) = \alpha x + \sum_{j=1}^{J} w_j \beta_j z(j). \tag{14}$$

Because the alternative-specific regressors in the system (equations [1] through [5]) are comprised only of the credit program dummy variables, equation (14) can be further simplified. Indeed, let $(D_1,\ldots,D_J)$ be the J dimensional vector of program dummies corresponding to the mutually exclusive J alternative choices defining the strata. Also, let

[28]The Manski-McFadden estimator estimates the population parameters of the conditional probability choices $p(j|x)$.

[29]For the sake of simplicity, equation (13) does not take into account the additional terms arising from the possible simultaneity of some of the regressors in x and $z(j)$.

j_i designate the stratum or alternative choice of the i^{th} household. Then, for the i^{th} household, we have the following, after dropping one of the (redundant) dummy variables:

$$\beta_j z_i(j) = \sum_{k=1}^{J-1} \beta_k D_k(j_i) \quad \textit{with} \ D_k(j_i) = 1 \ \textit{ if } j_i = k \ \textit{ and } \ 0 \ \textit{ otherwise}. \qquad \textbf{(15)}$$

Hence, the sample analogue of equation (14) can be written as

$$\tilde{E}(y_i|x_i) = \alpha x_i + \sum_{j=1}^{J-1} w_{j_i} \sum_{k=1}^{J-1} \beta_k D_k(j_i) = \alpha x_i + \sum_{j=1}^{J-1} w_{j_i} \beta_j D_{j_i}(j_i) = \alpha x_i + \sum_{j=1}^{J-1} \beta_j w_{j_i} \quad i=1,\dots,n. \qquad \textbf{(16)}$$

As claimed in this paper, equation (16) shows that the choice-based sampling correction concerns only the equations where the program dummies appear as regressors and the correction consists simply of replacing the program dummies by the corresponding consistently estimated choice-based-corrected conditional probability choices.[30] Of course, the estimated β_j parameters have to be interpreted accordingly.

[30]Again, as noted in footnote 29, equation (16) does not take into account the additional terms arising from the possible simultaneity of some of the regressors in x and $z(j)$.

APPENDIX 2

Definition and summary statistics of variables used in the model

Variable	Mean	Standard Deviation	Minimum	Maximum	N	Label
AGEH	45.82	13.76	20.0	86.0	1,885	Age of head of household
AGLPAREA	81.35	19.02	0	100	1,885	Percent of share of household agricultural land out of total land
CALORYC	2,056.38	951.92	241.18	9,654.11	1,885	Per capita daily calorie intake
CDTH3Y	.26	.45	0	2	1,885	Number of deaths in household within last 3 years
CDWAGE	.11	.31	0	1	1,885	1 = Has a daily wage contract
CFCWAGE	.09	.29	0	1	1,885	1 = Has a fixed work contract
CILLAC3Y	.18	.52	0	5	1,885	Number of illnesses/accidents in household in last 3 years
CINC94	192.89	440.67	-324	4,864	1,885	Total household net crop income (1994, MK)
CINC95	571.79	1,089.60	-161	10,985	1,885	Total household net crop income (1995, MK)
CPVENT3Y	.51	.89	.00	8.00	1,885	Number of positive events in household in last 3 years
CROPRISK	7.78	1.53	5	10	1,885	Index of crop risk 1 to 9
CVG9495P	1.24	.34	.85	2.03	1,885	1994/95 gaps within-peak season coefficient of variable
CVGAPYYP	.30	.06	.20	.45	1,885	Coefficient of variable across years of days of gaps (no rain)
CWMWAGE	.12	.33	0	1	1,885	1 = Has a weekly/monthly wage contract
DEPRATIO	.49	.22	.00	1.00	1,885	Dependency ratio: (population < 15 and > 64)
DISTFA	2.33	3.75	.00	15.00	1,885	Distance to Field Assistant's/Community Development Assistant's home
DISTPO	6.64	7.70	.00	26.00	1,885	Distance to post office
DISTPSCH	1.65	1.76	.00	5.00	1,885	Distance to primary school
DISTTCEN	5.04	5.16	.00	15.00	1,885	Distance to trading center
DISTUND5	3.72	3.46	.00	19	1,885	Distance from house to under-five clinic
DP9495	.60	.49	.00	1.00	1,885	1 = 1994/1995 data
DPASTMH	.24	.43	0	1	1,885	1 = Household is a past member of a credit program
EXPNFDC	20.77	38.49	.00	413.36	1,885	Per capita monthly nonfood expenditure
FAINRATT	.34	.20	.00	2.96	1,885	Transaction cost-adjusted formal interest rate
FAMTSTD	13.02	52.90	-145	846	1,885	MK outstanding on previous period formal loan
FARMERSV	.38	.49	0	1	1,508	1 = Saving keeper is a simple farmer
FARMLEND	.05	.22	0	1	1,885	1 = Lender is a simple farmer
FGIFTRV	4.21	22.10	0	417	1,508	MK value of NGO gifts received by household
FLOANMAX	70.50	172.91	0	2600	1,603	Maximum formal credit limit
FLOANVAL	30.75	110.09	0	2256	1,885	MK value of formal loans received
FNOCLCND	.06	.23	.00	1.00	1,885	1 = No condition on the formal loan
FOODEXC	3.96	3.00	.30	23.68	1,885	Per capita MK value household food consumption
FPDEFLT	.09	.29	0	1	1,885	1 = Has defaulted on past formal loans
FWEEKDLY	1.37	2.32	.00	26.00	1,885	Formal loan weeks of delay before receipt
HFAGEZ	-1.96	1.68	-7.71	4.45	1,046	Average height-for-age Z-score of under-6
IAMTSTD	.45	5.47	-4	100	1,885	MK outstanding on previous period informal loan
IDUEDATE	.26	.44	0	1	1,885	1 = Informal loan with fixed due date
ILLACCDN	.19	.49	0	4	1,885	Number of illnesses/accidents in household
ILOANMAX	25.14	49.39	0	743	1,511	Maximum informal credit limit
ILOANVAL	2.23	11.51	0	200	1,885	MK value of informal loans received
INOCLCND	.07	.25	0	1	1,885	1 = No condition on the informal loan
IWEEKDLY	.06	.28	.00	4.70	1,885	Informal loan weeks of delay before receipt
LANDAREH	1.96	1.41	.1	13	1,885	Total hectares of household land
LATRINE	.81	.39	0	1	1,885	1 = Has latrine
LCGIFTG	4.01	24.52	0	720	1,508	One period lag of cumulative gifts given
LCLOANG	8.48	35.81	0	566	1,508	One period lag of cumulative loans given

(continued)

Appendix 2 (continued)

Variable	Mean	Standard Deviation	Minimum	Maximum	N	Label
LDAOWNS	.43	.47	.00	1.00	1,885	Share of acres of household land owned by spouse
LDPASSTH	.51	.25	.0	1.0	1,885	Share of value of household assets held as land
LVPASSTH	.13	.20	.0	1.0	1,885	Share of value of household assets in livestock
MALEHEAD	.72	.45	0	1	1,885	1 = Male-headed household
MALELEND	.09	.29	0	1	1,885	1 = Lender is a male
MALESAVE	.38	.48	0	1	1,508	1 = Saving keeper is a male
MRFCH	.22	.42	0	1	1,885	1 = Household is a current member of MRFC
MUDZIH	.07	.25	0	1	1,885	1 = Household is a current member of MUDZI FUND
MUSCOH	.07	.26	0	1	1,885	1 = Household is a current member of MUSCCO
NCLWATER	.38	.48	0	1	1,885	1 = No access to clean water
NGOLEND	.01	.11	0	1	1,885	1 = Lender is a credit club member
NWLSBUY	.98	1.22	.00	4.00	1,885	Number of wholesale buyers coming to village
PCFERT95	2.13	.84	.94	6.67	1,885	1995 chemical fertilizer price (MK/kg)
PDASOWNS	.40	.46	.00	1.00	1,885	Share of value of household productive asset
PEVENTN	.41	.82	.00	8.00	1,885	Number of positive events in household
PHVKM	30.03	94.01	0	700	1,885	Distance from village of parents of head
PMERW1H	.16	.36	0	1	1,885	1 = Household is a current member of PMERW1
PMERW2H	.09	.29	0	1	1,885	1 = Household is a current member of PMERW2
POPADL15	2.56	1.26	0	8	1,885	Adult household members between 15 and 64
PPTOB95	12.17	3.98	2.00	30.00	1,885	1995 tobacco producer price (MK/kg)
PROTEINC	80.73	60.31	6.08	751.67	1,885	Per capita protein intake
PSHMZ95	3.88	1.36	.70	7.00	1,885	1995 hybrid maize seed price (MK/kg)
PSLMZ95	16.97	105.63	.33	2000.00	1,885	1995 local maize seed price (MK/kg)
PSTOB95	1.40	.41	.12	4.50	1,885	1995 tobacco seed price (MK/g)
PSVKM	26.55	77.20	0	600	1,885	Distance from village of parents of spouse
PVBEANS	8.12	2.86	3.70	25.00	1,885	Village consumer (weighted) price of bean
PVCASVA	2.78	1.51	.55	6.45	1,885	Village consumer (weighted) price of cassava
PVCATL	776.77	474.93	95	3000	1,885	Village-level (weighted) prices of cattle
PVCHKD	223.77	728.19	5	5106	1,885	Village-level (weighted) prices of chicken
PVDRINK	12.45	10.24	2.08	53.60	1,885	Village consumer (weighted) price of drink
PVGSHP	87.50	37.13	26	255	1,885	Village-level (weighted) prices of goats
PVMAIZE	1.52	.95	.08	6.16	1,885	Village consumer (weighted) price of maize
PVMEAFSH	8.37	3.07	.73	16.01	1,885	Village consumer (weighted) price meat/fish
PVOTHER	6.09	4.25	.24	19.79	1,885	Village consumer (weighted) price of other
PVOXEN	1,787.71	485.29	450	3000	1,885	Village-level (weighted) prices of oxen
PVVEGFRT	2.21	.94	.11	6.89	1,885	Village consumer (weighted) price of vegetables
RELALEND	.06	.23	0	1	1,885	1 = Lender is a relative of borrower
RICHLEND	.08	.27	0	1	1,885	1 = Lender is richer than borrower
RISKSTOR	2.01	.52	1	3	1,885	1 = Severe crop storage loss
SHTRADEL	.04	.21	0	1	1,885	1 = Lender is a shopkeeper or trader
SINCS95	.76	3.82	.0	67	1,885	Share of spouse cash income in 1995
SOUTH	.24	.43	0	1	1,885	1 = Southern region
SVLGLEND	.09	.29	0	1	1,885	1 = Lender lives in same village as borrower
TASSETVH	2,111.13	4,187.78	130	79991	1,885	MK total value of all assets owned by household
TCONSC	139.75	105.62	10.15	762.77	1,885	Per capita monthly food and nonfood expenses
THHINC95	1,187.84	1,549.13	-29	13413	1,885	Total household income in the 1994/95 season
THHNFINC	227.31	511.27	0	6154	1,885	Total household nonfarm-seasonal income
VPOORER	.20	.40	.00	1.00	1,885	1 = Village is poorer than neighboring village
WFAGEZ	-.85	1.32	-4.91	12.17	1,046	Average weight-for-age Z-score of under-6
WFHEIZ	.17	1.16	-3.62	3.79	1,046	Average weight-for-height Z-score of under-6
WSL12MHH	1.01	1.92	.00	17.33	1,885	Average weeks of sickness in last 12 months in household
YYEDUCH	4.20	3.32	.00	12.00	1,885	Years of schooling of head
YYEDUCS	3.14	3.05	.00	10.00	1,885	Years of schooling of spouse

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