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Is relaxing equity constraints panacea for Malawi's green gold expansion? a fuzzy regression discontinuity design approach

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Abstract

This paper assesses the causal effect of relaxing equity constraints on the cultivation of tobacco in Malawi, a crop viewed by the local population as Malawi's green gold. Applying the counterfactual outcome framework we find that relaxing equity constraints substantially increases the amount of tobacco land cultivated by smallholder farmers, suggesting that there is scope for increasing tobacco production once equity constraints are relaxed among producers. These findings provide justification for extensive public financing of tobacco production in Malawi.

Keywords: *tobacco, equity constraints, counterfactual, treatment effect, Malawi*

1.0 Introduction

Faced with limited mineral resources, agricultural exports are a major source of foreign exchange earning for Malawi and the agricultural export base is dominated by tobacco, a crop viewed by the local population as Malawi's green gold, which contributes over 70 percent of the country's total export earnings (Jaffee, 2003). Currently, Malawi ranks among the top three world exporters of two types of tobacco; namely, fire-cured and burley. This is believed to be a consequence of the comparative advantage the country enjoys in the production of tobacco. Two decades after the launch of the anti- smoking campaigns and the steady decline in the tobacco world market prices, the Government of Malawi continues to face problems in diversifying away from tobacco despite the well acknowledged risks associated with over-dependency on one crop for export.

Consistent with this observation Mataya and Tsonga (1999) report that although the country has a potential to diversify beyond tobacco through commodities that are of high- value and less bulky such as spices, oil seeds, some horticultural crops, cotton and pulses, constraints such as the lack of a policy framework and a strategy for implementation, poor dissemination of technical and economic information about the crops, inadequate value-adding activities, and deficient access to production facilities continue to impede the diversification efforts. Tobacco is the only crop in Malawi which can be exported without value adding and still fetches better prices while other potential crops require value adding before they can fetch a price equivalent to that of tobacco. It is partly for this reason that Malawi might continue to rely on tobacco as the major source of foreign exchange. The argument above provides justification for a further investment in its production.

However, considering that tobacco production is capital intensive, the participation of poor households characterized by equity failure, in its production poses a big challenge. Furthermore the pro-poor focus of current government policies suggest the need for increased participation of the poor in productive activities and the development process as whole as a means to achieving meaningful and equitable growth. Therefore, the advocacy for credit support to households interested in producing tobacco, but are facing equity failure is justifiable and consistent with the general investment theory under equity failure. Several authors (eg .Eswaran and Kotwal (1990); Zeller Diagne and Mataya (1998); and Feder and Umali (1993)) have reported on the positive effects of access to credit on agricultural production. Zeller Diagne and Mataya (1998) report that although an increase in the land allocated to tobacco in Malawi in the late 1990's was a result of a policy reform that increased the tobacco quota to small holder

farmers, access to credit significantly increased the share of land allocated to tobacco at household level. This observation would seem to suggest that the absence of credit or indeed credit constraints limit the production of tobacco.

Nonetheless, de Janvry *et al.* (1997) argue that a lack of access to credit may not necessarily imply an unmet credit need. The preceding argument suggests that credit targeted at households that do not have unmated credit needs, will simply act as a substitute to their income and it will not have the same effect as when it is targeted at those with a genuine credit need. Due to difficulties in identifying the credit constraint status of a household, most studies resort to a simple measure of credit access; the amount of money borrowed by a household, which does not tell anything about the credit-constraint status (see for example , Simtowe, Diagne and Zeller 2008). This study used a rich set of data set collected by the International Food Policy Research Institute (IFPRI) in Malawi in 1994 to assess the impact of credit constraints on the cultivation of Tobacco. Using the direct elicitation approach proposed by Jappelli (1990), Diagne, Zeller and Sharma (2000) and Sawada et al. (2006), households are classified into credit constrained and unconstrained regimes. A simple comparison of the average tobacco land cultivated between equity constrained and the unconstrained households show no significant differences between the two groups. Similarly results based on the propensity score matching method do not show any significant difference in land cultivated for tobacco between constrained and unconstrained household. However, results based on the fuzzy regression approach using eligibility into a credit program as an instrument show that relaxing equity constraints increases the amount of land allocated to tobacco. The rest of the paper is organized as follows: in section two we present a review of tobacco production in Malawi. In section three we present the empirical framework and an econometric specification of the empirical model. The data used for the estimation is described in section four. In section five we present and discuss results, while section six concludes.

2.0 Tobacco production in Malawi: a review

Malawi has a long history of tobacco production dating as far back as the 1890's. By 1964 tobacco had become the most important export crop for Malawi. Until the 1980's, participation in the production of tobacco was restricted to what Jaffee (2003) calls an elite cadre of growers who

owned or leased estates. Smallholder farmers were restricted in the varieties of tobacco which they could cultivate and were restricted to whom they could sell. Most small holder tobacco was sold to government agencies where they received lower prices than the prevailing market prices while large farmers could sell their tobacco directly to the international buyers. As noted by Jaffee, the special crops Act (1964) restricted small holder farmers from cultivating higher value crops such as burley and flue-cured varieties of tobacco. During the 1980's government encouraged the establishment of mini estates (10-20 hectares) for the production of tobacco resulting into the growth of the industry. By 1994 the government amended a special crops Act and expanded tobacco sales quotas to groups of smallholder farmers. This led to an increase in the land allocated to burley tobacco as indicated in Figure 1. The area of land located to all types of tobacco steadily increased from about 33,000 hectares in 1987 to about 127000 hectares in 2003.

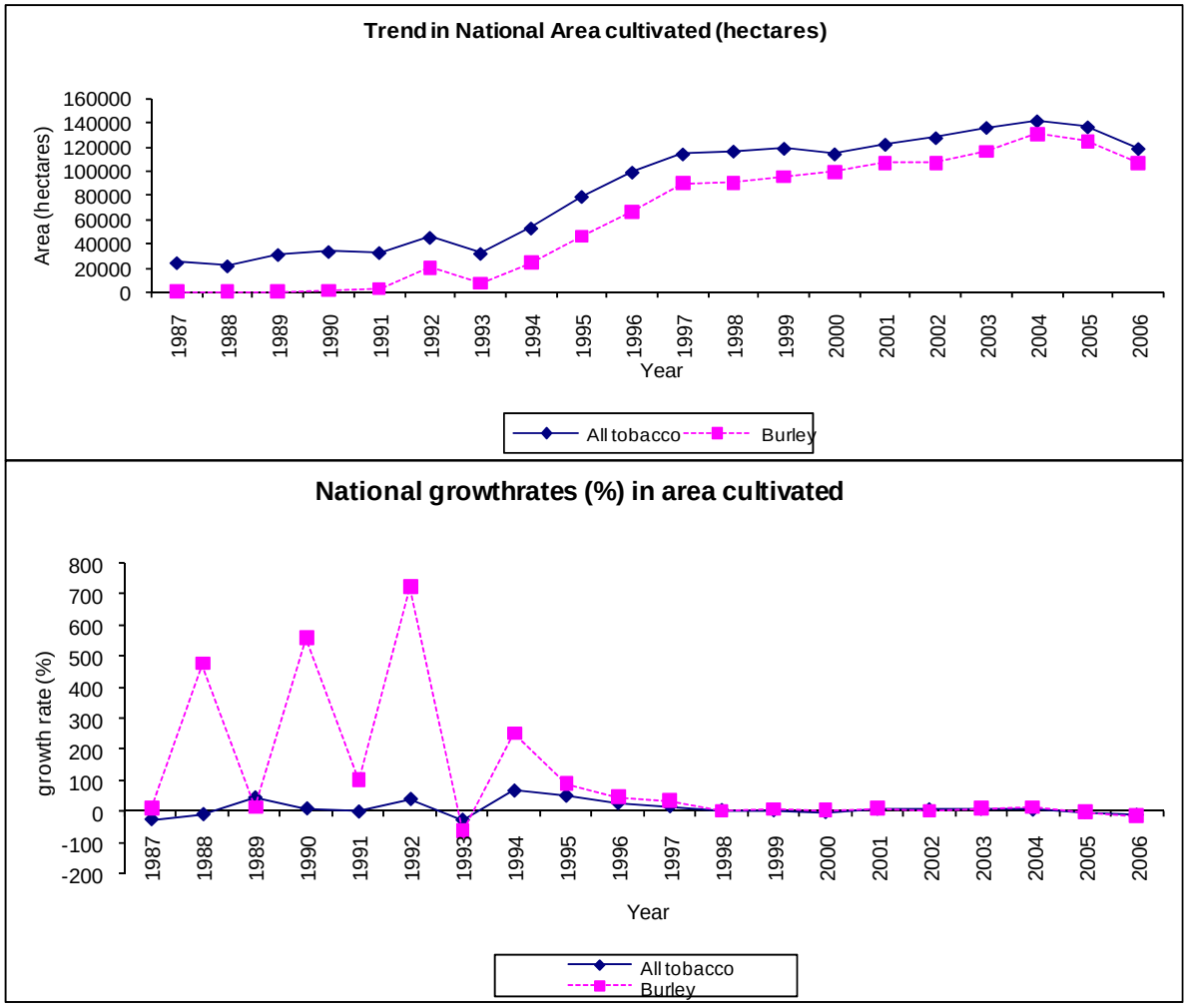

Figure 1: Trend in Area cultivated and annual growth rate for all Tobacco and burley Tobacco
Source: Government of Malawi statistics (2007)

Most of the increase in the land allocated to tobacco was a result of the extensive cultivation on burley tobacco by small holder farmers. The full liberalization of burley tobacco growing for the small holder farmers in 1994, led to an increase in proportion of land allocated to burley tobacco from 22 percent in 1994 to about 84 percent in 2003. Zeller, Diagne and Mataya (1998) note that the increase in the tobacco quota for small holder farmers was supported with improved access to extension, credit, inputs and improved access to markets that offered them with good prices at the auction floors.

The increase in the production of tobacco meant that more households are participating in one way or another in the tobacco industry. Today the tobacco industry provides employment to approximately 1.1 million workers and 390 thousand tenants. Tobacco is the most widely grown crop after maize covering more than 1,500 hectares of land (Government of Malawi, 2000). Interestingly, even after such an increase in the land allocated to tobacco Malawi still fails to meet its tobacco quota at the world market. Malawi's total tobacco production is currently estimated at 90 million kilograms against a total demand of 140 million kilograms estimated by the Tobacco Exporters Association of Malawi (TEAM). Two factors are believed to explain this gap between the supply and demand. The first is the fluctuating and lower than average price price-setting that discourages production. Related to this is the limited effective demand for fertilizers due to limited access to credit for financing tobacco production (Tchale *et al.*, 20001).

So far there is limited literature that has seriously looked into the extent to which access to credit encourages households to participate in the production of tobacco. This study is a first attempt to fill this gap by investigating the role of credit on the adoption of tobacco while taking into account the household credit constraint status.

3. Theoretical framework and econometric specification of the empirical model

3.1 Identification of equity constraints

The analysis in the present paper is based on the hypothesis that equity constraints are a barrier to the cultivation of tobacco by most poor households. We start by presenting a framework of household consumption and equity constraints and then apply it to the cultivation of tobacco. Following Diagne and Zeller (2001), Jappelli (1990), and Sawada et al. (2006) we construct a qualitative response model of endogenous credit constraint by defining an indicator variable of credit constraints cc. We do so by assuming that a household consumes some amount of goods C in a given period of time. Let C^* represent the optimal consumption in the absence of credit constraints. $C^* = C$ (the actual consumption) if the credit constraint is not binding; $C^* > C$ if the credit constraint is binding. The gap between optimal consumption and the actual consumption measures the existence or not of a credit constraint. We assume that the consumption gap is

defined as $H^* = C - C^*$. According to Jappelli (1990), Sawada et al. (2006) and Gilligan et al. (2005), there are two factors that determine whether or not a household will face credit constraints. The first factor is the demand for credit which is the difference between household resource endowment and desired consumption. The second factor relates to the supply of credit by financial institutions. The optimal consumption C^* and the maximum available credit to the household can both be expressed as a linear function of observables such as the household's human and physical capital. A reduced form equation of the consumption gap can thus be written as follows:

$$H^* = w\gamma + \mu \qquad (1)$$

$$cc = \begin{cases} 1 \; if & H^* < 0 \\ 0 \; if & H^* \geq 0 \end{cases}$$

Where:

w represents household and farm characteristics that determine credit demand as well as the supply of credit to the household.

μ is a random error term with zero mean.

A household is said to have a binding credit constraint if H*<0 and thus cc=1. The credit constraint is not binding if $H^* \geq 0$ and thus $cc = 0$

3.2 The causal effect of relaxing equity constraint and the counterfactual framework

The analysis on the effected of relaxing equity constraints on the cultivation of tobacco is guided by a Counterfactual framework proposed Rubin (1974) which assumes that each farm household has ex-ante two potential outcomes: an outcome when under equity failure that we denote by y_1 and an outcome when equity constraints are relaxed which we denote y_0.[2] Letting binary treatment variable cc to stand for the equity constraint status, with cc =0 meaning equity constrained, and cc =1 for the non constrained, we can write the *observed* outcome y of any farm household as a function of

[2] The outcome analyzed in the empirical section is the amount of land cultivated for tobacco

the two potential outcomes: $y = ccy_1 + (1-cc)y_0$ where y_1 is the outcome when under treatment (relaxed equity constraint), and y_0 is outcome when not receiving treatment (constrained). For any household the causal effect of relaxing equity constraints on its observed outcome y can be expressed as the difference of its two potential outcomes: $y_1 - y_0$. However the two potential outcomes are mutually exclusive for any household such that it is impossible to measure the individual effect of relaxing equity constraints on tobacco cultivation for given household. The challenge, therefore is to create a counterfactual sample that can be used as a control group to estimate the mean effect of relaxing equity constraints on tobacco cultivation among a population of households: $E(y_1-y_0)$, where E is the mathematical expectation operator. Such a population parameter is called the average treatment effect (ATE).

Several methods have been proposed to estimate the Average Treatment effect (ATE) and they include the matching methods, as well as regression and Instrumental variable based methods.However, matching methods only control for the observables that are responsible for one's participation in a treatment, but they do not control for other unobservable characteristics that may also influence one's participation in a treatment as well as the outcome of interest, (see for example Lee, 2005; Rosenbaum, 2002; Heckman and Vytlacil, 2005; Rosenbaum, 2002). Furthermore, in the presence of the *non-compliance* problem whereby subjects may not stick to their assigned groups even if assignment to the treatment and controlled groups were to be done randomly as in controlled social experiments (Imbens and Rubin 1997; Heckman, 1996; Imbens and Angrist, 1994), the estimates from propensity score matching will be biased..

In the present study of the effect of relaxing equity constraints through formal credit for eligible participants, *noncompliance* means that there are individual who can never borrow even though they area credit constrained because they are not eligible, and also that some households are not credit constrained and yet they are eligible to borrow. Therefore, under such a context (non-compliance), the ATE parameter estimated with the propensity score matching method does not identify the causal effect relaxing equity

constraints on the population. Instead, it identifies what is defined in the evaluation literature as the *intention-to-treat effect* (ITT).

Imbens and Angrist, 1994 indicate that in the presence of non-compliance, the impact parameter that identifies the causal effect on the outcome of interest is the *local average treatment effect* (LATE). This is the effect of a treatment on the subpopulation of "*compliers*".In this context of this study the subpopulation of compliers corresponds to that of eligible borrowers whose equity constraints could be relaxed through borrowing. Therefore, we estimate the potential effect of relaxing equity constraints on tobacco cultivation among smallholder farmers from Malawi that are eligible for tobacco credit from microfinance institutions and compare the results with estimates based on simple mean differences and propensity score matching methods that do not control for non-compliance. .

The econometric expression of relaxing equity constraints on the cultivation of tobacco can be presented in two interrelated equation as follows:. The first equation is equity constraint equation (equation no. 1) and the second (equation np.2) is the tobacco cultivation equation in which the equity constraint status of a household (*cc*) is included as an explanatory variable as in the following equation:

$$y = \alpha cc + x_M \beta_M + \varepsilon \qquad (2)$$

Where, y is the household's land allocated to tobacco in each reference season, x_M is a matrix of household specific socioeconomic and demographic characteristics that affect tobacco cultivation. Variable cc is an indicator of equity constraints which takes the value of zero if the equity credit constraint is binding and one otherwise. It is assumed that relaxing equity constraints has a positive effect on the cultivation of tobacco. The last term ε, is the error. Where (μ, ε) is assumed to have zero mean, bivariate normal distribution with a unit variance and $\rho_1 = Corr(\mu, \varepsilon)$. The covariate matrix is written as follows;

$$\begin{bmatrix} \sigma & \rho \\ \rho & 1 \end{bmatrix}$$

Green (2000) notes that if $\rho_1 \neq 0$, then μ and ε are correlated, and that an estimation of equation (2) is inconsistent for α and β.

Propensity score matching estimates

In observational data it is not possible to calculate directly the difference in the outcome of interest between the treated and the control group, also known as the Average Treatment effect (ATE) due to the absence of the counterfactual. As a consequence data may be drawn from comparison units whose characteristics match those of the treated group. The average outcome of the untreated matched group is the assumed to identify the mean counterfactual outcome for the treated group in the absence of a treatment (Cameron and Trived, 2005). The estimation using propensity score matching is based on the conditional independence assumption which states that conditional on X (observables), the outcomes are independent of the treatment (*cc*). In the present study this can be expressed as follows:

$$yi, yo \perp cc \mid X \qquad (3)$$

Furthermore the propensity score matching methods is based on the overlap or matching (support condition) assumption. The assumption ensures that for each value of X, there are both treated and untreated cases. The assumption is expressed as follows:

$$0 < \Pr[cc = 1 \mid x] < 1 \qquad (4)$$

This implies that there is an overlap between the treated and untreated samples. Stated the other way round this also means that the control and treated populations have comparable observed characteristics. The propensity score matching method matches treated and untreated cases on the propensity score rather than on the regressor. The propensity score which is the conditional probability of receiving treatment given X, is denoted P(X). In literature, there are a number of matching methods, and in this paper we apply the nearest neighbors, kernel and radius matching methods to assess the impact of relaxing

equity constraints on the cultivation of tobacco. The three methods are also used to test the robustness of the findings.

Regression discontinuity design estimates

The estimation based on propensity scores assumes continuity in all the observables. However in a special case of controlling for an observable variable where the probability of assignment to the treatment group is a discontinuous function of one or more observable variables (Duflo et al. 2006), propensity score matching methods do not yield reliable estimates In the case of credit access, for example, most micro credit organizations limit eligibility for credit to households that meet a certain minimum criteria. For tobacco credit in Malawi, the eligibility criteria comprise two important components. First, credit programs operating in Malawi provide group loans that are tied with a joint liability clause for the group members. Therefore, only individual belonging to a credit group have access (are eligible) to such loans. Second, we note that most of the agricultural credit programs require that individuals at least own 0.5 acre of land, however for tobacco households are required to own at least 1 acre of land. We find that for tobacco cultivation, the specified cutoff point for land size is quite relevant because households owning less than 1 acre of land and are risk averse, are more likely to prioritize the cultivation of maize as a food security crop before they allocate land to the more lucrative tobacco. We therefore, generate an eligibility variable for an agricultural loan based on the two components; ie membership in a credit group and the minimum land holding size of 1 acre.

We are interested to explore the potential effect of expanding credit access to eligible and equity constrained rural households on the cultivation of tobacco. Thus, our interest is only in a subpopulation of constrained households that are eligible to borrow. This warrants the estimation of the Local Average Treatment Effect (LATE) Abadie, 2003; Imbens and Angrist, 1994) as opposed to the Average Treatment Effect (ATE). There are two forms of regression discontinuity designs. First is the sharp regression discontinuity design. In this design, assignment to treatment solely depends on whether observable pre-intervention variables satisfy a set of conditions known to the analyst (Ichno, 2007). This

compares to a case where no household with land holding size below 1 acre accesses credit. However in this study, we are not interested in households with access to credit but rather in households facing equity constraints. We find that not all equity constrained households, are eligible to borrow for tobacco cultivation, and yet our interest is on credit constrained households that could borrow for tobacco cultivation.

When not all households that are eligible to borrow are constrained (ie credit constrained households are found on both sides of the cut-off point -credit eligibility) and vice versa, a fuzzy regression discontinuity design exists (see Table 1)

Table 1: Distribution of households cross the eligibility status and equity constraint

Eligibility status	Equity status		Total
	Equity constrained	Unconstrained	
Not Eligible	102	97	199
Eligible	69	136	205
Total	171	233	404

Source: Own Calculations from Malawi-IFPRI Survey

Duflo et al (2006) equates this situation to having no-shows (treatment group members who do not receive the treatment) and/or crossovers (control group members who do receive the treatment) in a randomized experiment. The existence of such mis-assignment makes it necessary to use a larger sample in order to preserve precision. The usual approach for dealing with mis-assignment (in the case of a regression discontinuity design) or non-compliance (in the case of an experiment) involves a simple form of instrumental variables analysis. Thus in this study we employ the Instrumental Variable (IV) method with the *eligibility status* as an instrument (see for example Abadie, 2003; Imbens and Angrist, 1994) to estimate the potential effect of relaxing equity constraints through credit among households that are eligible to borrow from a microfinance institution. Different IV based estimators are available depending on functional form, assumptions and assumptions regarding the instrument and the unobserved heterogeneities.

We assume a treatment effects model with an endogenous binary treatment cc and then estimate its effect on a continuous, fully observed variable y, conditional on the independent variables x and w. The primary interest is in the regression function (equation 2). In the proposed treatment model cc, is the endogenous dummy variable indicating whether the treatment is assigned or not. The binary outcome treatment cc is modeled as the outcome of an unobserved latent variable cc^*. It is assumed that cc^* is a function of the exogenous covariate w and a random component u. If we assume normality of distribution in the outcome of interest, the average treatment effect of relaxing equity constraints on the cultivation of tobacco conditional on the exogenous covariates $(\text{Yi} \mid y_i \mid x_M, cc = 1$ derived from equations 1 and 2 can be estimated using a Full Information Maximum Likelihood in STATA by executing the TREATREG command. The discussion of the procedure is discussed in detail in Woodridge (2002) .Woodridge reports that a convincing identification of this model requires that aleast one variable in x_M, ie a variable that determines one's likelihood of facing liquidity constraints is excluded from the outcome equation (land cultivated for tobacco), also known as the exclusion restriction. The policy interest in this study is to examine the extent to which equity constrained rural households that are eligible to borrow money from a microfinance institution, can use the money to expand their cultivation of tobacco.

However considering that the outcome of interest (tobacco land cultivated) is left censored at zero- thus there are no individuals that cultivate less than zero acres of tobacco land- which also violates normality assumptions imbedded in the earlier estimation using TREATREG, we estimate a second IV estimator using the IVTOBIT procedure in STATA which addresses both the censoring problem as well as the regression discontinuity problem by using the eligibility criteria as an instrument. In so doing we estimate the Local Average Treatment Effect of relaxing equity constraints among eligible credit borrowers on the cultivation of tobacco. We assume that eligibility status is correlated with the equity status of the household as eligibility to credit may relax equity constraints. We however assume that eligibility to a credit program does not

directly affect the individual's choice to produce tobacco except through the relaxation of the equity constraint which makes the eligibility criteria to be a valid and relevant instrument in the model.

4.0 Data

Financial services to micro enterprises and low income households in Malawi are provided by a variety and range of private and publicly supported Microfinance Institutions (MFIs) that include NGOs, Companies Limited by Guarantee, Savings and Credit Cooperatives and Commercial Banks including one bank specialized in microfinance. In the present paper we use the data collected by the International Food Policy Research Institute (IFPRI) in collaboration with Bunda College in Malawi in 1994 and which contains the necessary information needed to identify credit-constrained households as well as those that cultivated tobacco. The data set is certainly old which suggests that some conditions in Malawi in 2008 could be different from those in 1994 although to a large extent the poverty levels, the levels of access to financial services by the poor, as well as the structure of the agricultural sector have mostly remained the same. Therefore, aside from explaining the current conditions, our aim is to illustrate how using a well established survey data, one could ultimately measure the effect of relaxing equity constraints on technology adoption.

The IFPRI Survey was designed to investigate the effects of access to credit on household welfare. The survey covered households from five districts of Rumphi, Nkhotakota, Dowa and Dedza and Mangochi. The four microcredit programs that were of focus for the survey included the Malawi Rural Finance Company (MRFC), a state-owned and nationwide agricultural credit program; Promotion of Micro-Enterprises for Rural Women (PMERW), a microcredit program targeted at women in support of nonfarm income-generating activities; the Malawi Mudzi Fund (MMF), a replica of the Grameen Bank; and the Malawi Union of Savings and Credit Cooperatives (MUSCCO), a union of

locally based savings and credit associations. The IFPRI survey focused on these four microfinance institutions as representative of the spectrum of formal credit and savings options available to rural households in Malawi. The data were collected from members of credit programs as well as from non- credit program members. The sample included 404 households of which half were members of the credit programs and the other half were non-members.

The survey questionnaire consisted of several modules including household socio-demographics, crop and livestock production and credit and savings modules as well as Asset modules. The data are available on request from the International Food Policy Research Institute (IFPRI).

In the IFPRI survey, respondents were asked whether or not they had tried to borrow from a formal lender in the past 12 months. Those who asked for loans were asked the amount they received and whether they received the full amount demanded. Those that had not attempted to borrow were asked about the reasons for not attempting to borrow. More precisely, the questions were as follows:

1a Did any member in your household apply for a loan from a formal institution in the last 12 months? Yes/no

1b If household applied, was the loan granted ? Yes/no

1c If loan was granted was the household granted the same amount the loan as requested? Yes/no

2 If household members had not attempted to borrow, give reasons. The choices for the answers were as follows;

1= I did not need credit;

2=I dislike any borrowing

3= The loans are too expensive

4= I would have liked to apply for a loan but did not apply because I felt that lender would not give me a loan because of my age

5= I would have liked to apply for a loan but did not apply because I felt that lender would not give me a loan because of my health problems

6= I would have liked to apply for a loan but did not apply because I felt that lender would not give me a loan for other reasons other than age and health problems

7=Others

Respondents who chose any of the options 3, 4, 5 and 6 as reasons for not attempting to get a loan from a formal institution (question 2) are categorized as discouraged borrowers, and consistent with the credit literature, such households together with those that did not receive as much credit at the requested from the formal lender were classified ascredit constrained. About 43 percent of the surveyed households were classified as credit constrained.

Table 2 presents household characteristics divided by credit constraint status. Unconstrained households have relatively larger households (6.1 persons) than constrained households (5.4 persons). Results further show that unconstrained households are wealthier with an average household asset value of MK 4168 compared to MK 3293 for the credit constrained (at the time of the survey, 1 US Dollar was worth 44 Malawi Kwachas) Unconstrained households have a much smaller proportion of female-headed households (21%) than households that have some credit binding constraint (30%) suggesting that credit constraints in Malawi could be associated with the gender of household head. Unconstrained households have larger land holdings (2.47 hectares) than constrained households (1.8 hectares). There are no marked differences in terms of age, years of education of the head of household.

Table 2: Household characteristics by credit constraint status

	Unconstrained households (n=233)	Credit constrained households (n=171)	Total (n=404)
Age of head (years)	45.01	45.18	45.13
	(12.19)	(14.08)	(13.58)
Years of schooling of head	4.65	4.15	4.28
	(3.46)	(3.25)	(3.31)
Sex of head of household (1=male, 0=female)	0.79	0.70	0.72
	(0.41)	(0.46)	(0.45)
Population males 15 to 64 years	1.27	1.21	1.22
	(1.03)	(0.83)	(0.89)
Population females 15 to 64 years	1.48	1.47	1.47
	(0.77)	(0.83)	(0.81)
Household size	6.10	5.41	5.59
	(2.83)	(2.46)	(2.58)
Total hectares of household land	2.47	1.87	2.03
	(2.51)	(1.66)	(1.93)
Distance to Field assistant (kilometers)	2.75	2.04	2.23
	(3.91)	(3.48)	(3.61)
Values of household assets (Malawi Kwacha)	4168	3293	3527
	(12601)	(6794)	(8723)
Whether received free inputs from government (%)	15	18	16

Source: Own Calculations from Malawi-IFPRI Survey
* Figures in parenthesis are standard deviations

About 40 percent of the sampled households were classified as adopters. Table 2 presents selected characteristics of farmers differentiated by the adoption status of a farmer. They include socio-economic characteristics such as age, sex and education level of a household head. We also include wealth status indicators such as land size, the value of assets and access to the extension services. Our a priori expectation is that wealth proxy variables will have a positive effect on the tobacco cultivation (Feder, Just and Zilberman, 1985). We expect that credit constraints will have a reducing effect on the amount of land allocated to tobacco. We also expect farmers close to extension service centers and markets to allocate more land to tobacco due to the market incentives as well as due to access to extension services.

Household characteristics disaggregated by the status of tobacco cultivation of a household (Table 3) indicate that tobacco growing households are predominantly headed by

males, accounting for 84% of households in the the tobacco growing sub-sample while a lesser proportion of 70% of households among the non-tobacco growers were male-headed households. The findings suggest that tobacco production in Malawi has a gender face, to the extent that women are structurally or otherwise discouraged from participating in the production of the lucrative crop. This not unexpected considering that women farmers are likely to face labor as well as liquidity constraints, both of which are key factors in the production of tobacco.

There are no marked differences in terms age, education and wealth (as measured by asset value) between tobacco growers and non growers. Tobacco growers, however have access to higher values of formal credit (Mk1142) than non-growers (Mk869). Furthermore, tobacco growing households have larger households sizes (6.8 persons) than non-growing households (5.3 persons) and indication of the importance of family labour in tobacco cultivation. Tobacco growing households also have significantly larger ($P<0.05$) land holdings (2.8hactares) than non-tobacco groeing households (2.04 hectares). Although tobacco growing households are far from the extension workers they are more frequently visited by extension agents than non-tobacco growing household. This is consistent with expectation in that tobacco generally attracts more attention from government extension agents as well as credit officers who lend to farmers for tobacco production and are, therefore, keen to see that the borrowers manage the crop well to enable them repay the loan.

Table 3: Household characteristics by tobacco cultivation status

Household characteristic	Tobacco growers (n=80)	Non-tobacco growers (n=324)	Total (n=404)
Age of head (years)	45.7 (14.1)	45 (13.4)	45.13(13.58)
Years of schooling of head of household	4.7 (3.3)	4.2 (3.3)	4.28 (3.3)
Sex of head of household (1=male, 0=female)	0.84 (0.4)	0.70 (0.5)***	0.7 (0.4)
Population males 15 to 64 years	1.3 (0.8)	1.2 (0.9)	1.2 (0.8)
Population females 15 to 64 years	1.5 (0.8)	1.5 (0.8)	1.5 (0.8)
Household size	6.8 (23.0)	5.3 (2.4)***	5.59 (2.5)
Total hectares of household land (hectares0	2.2 (1.6)	1.5 (1.2)***	2.03 (1.9)
Distance to extension worker's home (kilometers)	2.70 (3.98)	1.92 (3.30)	2.23 (3.6)
Values of household assets (Malawi Kwacha)	3299 (5862)	3463 (1018)	3432 (8723)
Number of visits by an extension agent	7.9 (1.2)	1.9 (1)**	3.0 (1)
Maximum amount credit accessible (MK)	1142 (1853)	869 (977)**	944 (1280)

Source: Own calculation from RDD/IFPRI Rural Finance Survey
*** Significant at 1% level
* Figures in parenthesis are standard deviations

5.0 Results and discussions

Table 4 indicates results on tobacco cultivation disaggregated by liquidity constraint status of a household. Although unconstrained households had large land holdings, mean comparisons of the incidence of tobacco cultivation between the two categories suggests that there were no significant differences. About 18% of the unconstrained households grew tobacco, against 19% of the constrained households, and the difference between the two categories of households was insignificant. Similarly, there was no significant difference in the size of land allocated to tobacoo between constrained and unconstrained households. With regard to the proportion of land under tobacco cultivation, tobacco land accounted for 11% of the total land cultivated. Furthermore there are no significant differences in the proportion of land allocated to tobacco between constrained and unconstrained groups. Based on these findings, we may conclude that the relaxation of liquidity constraints has no effect on the amount of tobacco land cultivated.

Table 4: Tobacco cultivation between constrained and unconstrained farmers

	Liquidity constrained	**Unconstrained**	**Difference**	**All**
Average land holding (hectares)	1.87	2.47	1.4**	2.3
Percent growing tobacco (%)	18.7	18	0.7	18
Land cultivated for tobacco (hectares)	0.25	0.27	-0.01	0.26
% land allocated to tobacco	11	15	4	13

But these observed differences between constrained and unconstrained farmers do not tell much about the intrinsic impact of relaxing equity constraints on tobacco cultivation. In order to clarify this dilemma we apply the counterfactual outcome framework to estimate to estimate the impact of relaxing equity constraints on the area of tobacco land cultivated. We start with start by applying the propensity score matching methods and then later apply the TREATREG and IVTOBIT procedures in STATA.

Table 5 indicates estimates of the effect of relaxing equity constraints based on the propensity score matching method. The average difference between equity constrained households and unconstrained households for the matched cases is considered as the average treatment effect of relaxing equity constraints on the amount of tobacco land cultivated. Column 2 indicates the average size of tobacco land among treated cases that are matched with untreated cases while column 3 shows the same for the control group. The average treatment effect of relaxing equity constraints on the size of tobacco land cultivated is the difference in the average land cultivated between the two groups. In general, the impact estimates are quite similar across the three estimation methods, an indication of the robustness of the results. However, the impact estimates are not significant, suggesting that conditional on propensity scores, relaxing equity constraints does not significantly increase the size of the tobacco land cultivated. However, the estimates based on propensity score matching may be biased in the presence of non-compliance and other forms of hidden bias. Furthermore the PSM methods assess the effect of relaxing equity constraints on a person randomly selected from the population. This parameter is not meaningful as not all farmers can potentially grow tobacco due to

land constraints and other preferences. Furthermore we are interested in farmers that are eligible to borrow from microfinance institutions for tobacco cultivation. This implies that our interest is on a sub-population of farmers that may grow tobacco once equity constraints are relaxed through credit.

Table 5: The effect of relaxing equity constraints on tobacco land cultivated

	Treated	Controls	Difference=average treatment effect on the treated	t-stat
Method 1- Nearest neighbor				
No of matched observations	141	85		
Tobacco land cultivated (acres)			0.04	0.20
Method 2 – Kernel matching				
No of matched observations	142	85		
Tobacco land cultivated (acres)			0.04	0.16
Method 3- Radius matching				
No of matched observations	222	158		
Tobacco land cultivated (acres)			-0.01	-0.16

Table 6 presents the results on determinants of the amount of land allocated to tobacco following the relaxation of equity constraints from the treatment effects model which corrects for the endogenous equity constraints and estimated using TREATREG in STATA. In addition to the equity constraints variable, we include other variables theoretically linked to technology adoption as explanatory variables to assess their effect on tobacco cultivation.

Column 2 presents coefficients estimates of the tobacco cultivation equation while column 4 presents coefficients for the credit constraint equation. One of the parameters of interest, the rho or which measure the correlation between the errors in the credit constraint equation (equation1) and the reduced-form adoption equation (equation 2) is -1.08 and significantly different from zero (Chi square=0.0000).

Table 6: The effect of relaxing equity constraints on tobacco cultivation -treatment regression-

Variables	Determinants of amount of land cultivated for tobacco		Determinants of credit constraints (1=unconstrained, 0=Otherwise)	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Relaxed liquidity constraint	1.0616***	0.1157		
Age household head	-0.0012	0.0036	0.0069	0.0052
Education head	-0.0014	0.0173	0.0398	0.0251
Gender (1=male)	-0.0310	0.1073	0.2823*	0.1499
Household size	0.0562***	0.0199	-0.0050	0.0288
Total land holding	0.1175***	0.0332	0.0985*	0.0537
Maize area	-0.0229	0.0311	-0.1320***	0.0453
Distance to extension officer	0.0080	0.0147	-0.0080	0.0215
Distance to commercial bank	-0.0232***	0.0086	0.0043	0.0121
2nd Quartile for value of assets	-0.1072	0.1483	0.2773	0.2072
3rd Quartile for value of assets	-0.0133	0.1556	0.1233	0.2241
4th Quartile for value of assets	0.0648	0.1598	-0.0516	0.2320
5th Quartile for value of assets	-0.2054	0.1728	0.2419	0.2480
Mangochi	1.0613**	0.4678	-0.4016	0.6547
Nkhota	0.8774***	0.2859	-0.5850	0.4037
Rumphi	0.6068***	0.1799	-0.2021	0.2634
Dedza	0.2750	0.2014	0.0646	0.2894
Constant	-0.5249*	0.2743	-0.5540	0.3893
Eligibility for tobacco credit			0.4300***	0.1094
/athrho			-1.0852***	0.1095
/lnsigma			-0.1282**	0.0514
Rho			-0.7951	0.0403
Sigma			0.8797	0.0452
Lambda			-0.6995	0.0660

S ource: Own calculation from RDD/IFPRI Rural Finance Survey
* ,**, ***. Significance at 10%, 5%, and 1 % level,
Figures in parenthesis are standard errors

These findings suggest that the variable (credit constraint) is endogenous and thus we cannot reject the null hypothesis for no endogeneity of the credit constraint status of a household. The results for determinants of equity constraints (column 4) show that male-headed households are less likely to face equity constraints than female-headed households. Furthermore, households with larger landholdings are less likely to report credit constraints than those with smaller land holdings. The eligibility status of a household for tobacco credit (which also used as an instrument) in the regression reduces

the propensity of facing equity constraints. This finding suggests that households that have an option of borrowing for tobacco cultivation are less likely face equity constraints.

The results on determinants of the amount of tobacco land cultivate (column 2) indicate that relaxing equity constraints significantly (at 1%) increases the amount land allocated to tobacco. Other variables of importance include gender of household head, household size, total land holding size, distance to the commercial bank as well as district dummy variable.

The finding that relaxing equity constraints increases land cultivation tobacco is consistent with prior expectations as tobacco is a capital intensive crop require significant amounts of fertilize , chemicals and labour. In the study areas in particular, formal credit is provided for farm production as well as for off-farm employment activities and, therefore, these results are not unexpected. .

Labor availability is an important variable affecting farmer's decision on whether or not to adopt a technology. In this study the household size was used as a proxy for labor availability. The size of a household has a positive and significant effect on the size of tobacco land. The positive effect can be explained by the fact that tobacco is a labor intensive crop, and thus households with more labour will cultivate more land. Furthermore, consistent with prior expectation households with larger land holdings cultivated more tobacco.

However, the results in Table 6, do not consistently explain the impact of relaxing equity constraints on tobacco cultivation because the dependent variable of interest (land cultivated) is left censored and thus consistent estimation of the model has to be done using censored models such as the Tobit model or the IVtobit in the case of an endogenous independent variable. The results presented in Table 7 are therefore based on the IVtobit regression in which the eligibility criteria for tobacco cultivation is included as an instrument. The results show that relaxing equity constraints has a much higher effect on the amount tobacco land cultivated. The coefficient of the equity constraint variable is larger (8.36), suggesting that relaxing equity constraints increases land cultivated for tobacco by eight (8) acres, much higher than the effect of 1 acres reported in the TREATREG model in Table 6. The only other important variable from

results in Table 7 is household size and distance to the commercial bank with coefficient returning the same sign as in Table6 from the TREATREG estimation. Interestingly, land holding size is not significant in explaining tobacco cultivation in Table7.

Table 7: The effect of relaxing equity constraints on tobacco cultivation –IV-Tobit regression

Variables	Determinants of amount of land cultivated for tobacco		Determinants of credit constraints (1=unconstrained, 0=Otherwise)	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Relaxed liquidity constraint	8.3615***	3.4835		
Age household head	-0.0216	0.0244	0.0036*	0.0019
Education head	-0.1151	0.1040	0.0132	0.0092
Gender (1=male)	-0.1557	0.7185	0.1208**	0.0580
Household size	0.2620**	0.1133	-0.0051	0.0107
Total land holding	0.2073	0.2330	0.0127	0.0138
Maize area	0.1861	0.2156	-0.0385***	0.0148
Distance to extension officer	0.0534	0.0693	-0.0028	0.0074
Distance to commercial bank	-0.0966*	0.0576	0.0002	0.0046
2nd Quartile for value of assets	-0.9199	0.9735	0.1313	0.0829
3rd Quartile for value of assets	-0.1674	0.9742	0.0833	0.0850
4th Quartile for value of assets	-0.3416	0.9006	0.0068	0.0859
5th Quartile for value of assets	-1.5858	1.1751	0.1397	0.0939
Mangochi	-3.7317	2.6056	-0.0779	0.2571
Nkhota	3.9988**	1.9683	-0.1646	0.1567
Rumphi	2.6512***	1.0666	-0.0782	0.0955
Dedza	0.9940	1.2025	0.0361	0.1086
Constant	-6.3521***	1.9585	0.2798*	0.1481
Eligibility for tobacco credit			0.1574***	0.0521
/alpha			-8.4990**	3.5626
/lns			0.6118***	0.1189
/lnv			-0.7535***	0.0165
S			1.8438	0.2191
V			0.4707	0.0078

The results have interesting policy implications. First the fact they imply that relaxing equity constraints through the supply of credit to farmers that are eligible to borrow for tobacco cultivation, will potentially increase the amount of land cultivated for tobacco. Thus any policy aimed at promoting the production of the country's green gold should consider increasing the supply of credit to the farming households that are eligible to

borrow for tobacco cultivation, thus farmers with at least 1 acre of land and those that belong to a credit group that is eligible for credit.

Other variables that are insignificant include the gender of the household-head. The results on gender are particularly interesting as the seem to defy the general notion that tobacco is a men's crop, suggesting that once you control for credit constraints gender is not an issue in tobacco cultivation. Indeed this concurs with the observation that gender is a social construction that is perpetuated based on myths about women's inability to do things better than men, when infact these myths are just aimed at depriving women of the resources required to allow them participate in high return investments Other location dummies of importance that returned significant parameters are Rumphi and Nkhotakota. Households in these districts tend to allocate more land to tobacco production than households from Dedza and mangochi

6.0 Conclusions and policy implications

This paper investigates the effect of relaxing equity constraints on the cultivation of tobacco. It is motivated by the theoretical assumption that relaxing equity constraints through credit provided at market interest rates results into marginal benefits among credit constrained households but does no welfare enhancement for unconstrained households. Using a counterfactual outcome framework we show that a mere comparison of the average size of tobacco land cultivated between equity constrained and unconstrained farmers do not provide a reliable estimate of the impact of credit constraints on the outcome of interest.

The mean comparison of the size of tobacco land cultivated between constrained and constrained farmers does not show any significant differences. Furthermore results based on propensity score matching also that the impact of relaxing equity constraints on tobacco cultivation (ATE) is not significant. However results based on the parametric based methods which corrects for the bias associated with being equity constrained (the instrumental variable method) show that relaxing equity constraints among a sub-population of individuals that are eligible to borrow credit for tobacco cultivation leads to an expansion the size of land allocated to tobacco..The study findings suggest that extending credit to equity constrained households that are eligible to borrow credit for tobacco cultivation can potentially contribute to the expansion of land under tobacco cultivation in Malawi..

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