One size fits all? Female Headed Households, Income Risk, and Access to Resources

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***Abstract*— Studies dealing with productivity in female (FHH) and male headed households (MHH) find that FHH appear to be either less, equally, or more productive compared to MHH. Lower productivity of FHH is often explained by insecure access to land, while the findings of higher productivity largely remain unexplained. This paper is an attempt to reconcile these contrasting findings by constructing a model that accounts for productivity effects arising from secure land rights and the risk of falling short of income. Both affect productivity, but they do so in opposite directions. While tenure insecurity tends to decrease labor effort, income risks increase it as subsistence farmers want to avoid falling (deeper) into poverty. Depending on which of these risks prevails in the perception of farmers, they become either more or less productive than a benchmark farmer who faces none of these constraints. The model is tested using data from Kenya where FHH are categorized by different land tenure security schemes. The results from a stochastic cost frontier model establish that FHH facing tenure insecurity are less productive compared to MHH. However, this result only obtains in case households do not face income risks.**

Keywords— **Female headed households, tenure insecurity, income risk**

I. INTRODUCTION

Despite the often reproduced result of low productivity of FHH, other studies report mixed results. In their investigation of improved crop variety adoption, Dossa and Morris (2001) find that the adoption rate of hybrid maize is equal among FHH and MHH in Ghana. However, FHH were less likely to adopt modern varieties of other crops. Analyzing data from Benin and Malawi, Minot et al. (2000) find that FHH in Malawi are more likely to use fertilizer than MHH. For the case of Benin, there are no significant differences. In other instances, studies report that FHH achieve the same yield per hectare or produce even more than MHH (Bindlish and Evenson 1993, Moock 1976). In sum, it seems impossible to make *a priori* predictions on the productivity of FHH since they turn out to be less, equally or more productive compared with MHH.

This paper is an attempt to reconcile these findings by constructing a model that accounts for productivity effects which arise from tenure insecurity and the risk of falling short of income. Both affect productivity through the supply of labor, but they do so in opposite directions. While tenure insecurity tends to decrease labor effort, income risks increase it as subsistence farmers want to avoid falling (deeper) into poverty. Depending on which of these risks prevails in the perception of farmers, they become either more or less productive than a benchmark farmer who faces none of these constraints.[1]

A common prediction on how risk averse farmers respond to tenure uncertainty, is that they reduce effort and investment, i.e. they produce less output as compared to a risk neutral farmer (Feder et al. 1985, Besley 1995). A theoretical justification can be found in Sandmo (1971) who introduced price uncertainty into the profit maximization problem of a competitive firm. A major result of his study is that firms respond to uncertainty by reducing inputs and consequently produce less output. However, the theory has serious shortcomings when applied to the context of subsistence farming, where part of the output is consumed by the producers. Subsistence farmers cannot afford to reduce effort since lower output implies that they would fall into even deeper poverty. Early concerns about the applicability of Sandmo's model to subsistence farming are stated by Finkelshtain and Chalfant (1991) who theoretically demonstrate that depending on the share of home consumption and the income elasticity of household

1. [1] It should be noted that the concept of productivity used here does not imply that farmers in rural areas of developing countries do produce on a large scale. The produced output is often only slightly above the poverty line and being (relatively) productive often implies to produce a little more than in an environment that does not impose any risks on the farmer.

demand for the subsistence good, farmers may well produce more when exposed to income risk. They also find that the common Arrow-Pratt measure of risk aversion falls short in measuring the true risk aversion of subsistence farmers.

The model developed in this paper as well as the subsequent empirical analysis establish that how farmers respond to the risk associated with tenure insecurity depends on the availability of alternative income options which guarantee a certain level of income. A major finding presented here is that farmers switch between two different states which are determined by the probability of falling short of income. If this risk is high, farmers cannot afford to adjust their production to other risks like tenure insecurity as they otherwise would be even poorer. On the other hand, when the risk to fall into poverty is low, farmers respond to tenure insecurity by reducing production. This they do at an increasing rate, the farer they get ahead from their subjective poverty line.[2] The mixed results concerning the productivity of FHH in comparison to MHH may therefore be explained by their different exposures to income risk.

Studies concerned with comparisons of agricultural production between FHH and MHH usually neglect the fact that the concept of a FHH is multifaceted and not easily subsumed under a single heading. FHH may be distinguished according to a number of criteria as for example the marital status of the head of household, whether a woman is the household decision maker or the main income earner, etc. By applying these criteria, different implications arise for the welfare of the different categories of FHH (Dreze and Srinivasan 1997, Fuwa 2000, Kennedy and Peters 1992, Rosenhouse 1989). Furthermore, in some regions marital status, demographic characteristics and the position of a woman as being the main household decision maker determine the security of land rights, implying that each type of FHH should exhibit different patterns of production.

Tenure insecurity is not the only risk that women as heads of household are facing. Outmigrating husbands often leave the household and literally take the farm decision power with them, such that women are not allowed to do any on-farm investment decisions or crop choices. In what follows, I treat tenure insecurity and low levels of decision making competence interchangeably as they lead to the same conclusion regarding the incentive structure to invest in productivity increases.

Although the welfare implications arising from different forms of FHH have been investigated, as yet no study was done on the production side of FHH in smallholder farming in sub-Saharan Africa. Using a large scale household survey from Kenya which provides detailed information on household characteristics and farming, I distinguish eight different categories of FHH, each of which associated with a different scheme of incentives to invest into farming and investigate whether these household categories are sufficiently different to exhibit household specific patterns of production arising from different sets of constraints these households are subjected to.

II. THE PROBLEM OF CLASSIFYING FHH

The most common way to classify FHH is self-reported headship which is a standard question in most household surveys. Usage of this indicator in empirical studies is based on the assumption that FHH are a homogeneous group, thus ignoring that there are many ways out of which a FHH can emerge and according to which FHH can be categorized. One possible further classification is marital status, which includes marriage, widowhood, or divorced women. Another category may be demographic characteristics of the household. A significant number of FHH result from temporary outmigration of the husband, seeking employment in urban areas. Another example is polygamy which is still a wide spread pattern of family organization in sub-Saharan Africa. Polygamous households are often part of a larger household compound which is not necessarily captured by household surveys. Such a household may be identified as a FHH, although it belongs to an array of different but related household units where usually a man is responsible for household decisions. It is likely that such households operate under entirely

2. [2] The risk of falling short of income is at least partly a subjective risk as it depends on the personal perception of being poor or not. This is the reason why I am not referring to an explicit poverty line in the empirical section.

different conditions as compared to widows or unmarried women.

These criteria, though important means to identify different categories of FHH, do not comprise further interesting cases. Many FHH are characterized by the fact that men are entirely or in part responsible for on-farm decision making while in other cases women are the sole decision makers. Kennedy and Peters 1992 have classified these groups as *de facto* and *de jure* FHH, where only in the latter the woman is considered to be the legal and customary household decision maker. A *de facto* FHH on the other hand is characterized by a married woman whose husband is absent most of the time. Women in these households are not necessarily the principal household decision maker.

Before classifying FHH, it is necessary to ask for the specific constraints that women face. Women in many sub-Saharan African countries are disadvantaged in terms of access to land, which translates into difficulties to obtain credits and therefore agricultural inputs (see Gopal and Salim (1998) for an extensive review of women and land rights in Eastern Africa). In some cases, women are not allowed to register land in their names and are thus dependent on a male relative, be it their husband, father, brother, son, etc., who can hold a title for them. Even where legal reforms have brought about the right for women to possess land as in Kenya, men often registered all household land in their names, even if it customarily belonged to the woman. If the owner of the land title dies or separates, the woman may lose access rights to land as the titles are often passed to a male member of the family.

Land that is not entitled in the farmer's name cannot be used as collateral for obtaining credits, which inhibits the adoption of improved crop varieties and complementary inputs. Lack of collateral has been found to be a major reason why women tend to be excluded from credit programs (Saito et al. 1994). Failure to adopt modern technologies would therefore arise not necessarily due to a generally imperfect input market, but as a consequence of characteristics inherent to the social status of women farmers. But there are further issues that disadvantage women. Doss and Doss and Morris report that male extension workers are reluctant to visit women such that women are further constrained in obtaining information. Finally, men may be important for establishing business contacts and are often responsible for marketing cash crops. In rural Kenya, men often serve as middlemen between women and the market for capital goods and agricultural inputs (Savane 1986).

Whether a woman as head of household faces such constraints depends on the way out of which female headship has emerged. The death of the husband is an exogenous shock that immediately changes the woman's economic and social status. Such shock may imply that access to land becomes insecure. This holds also for the case of Kenya where, although land is legally a private property that can be sold, the major means to access land is through the family. Among the Kikuyu, who constitute the largest ethnic group in Kenya, land is allotted along patrilineages, where the `guardian' of the lineage assigns land to the sons. This is mostly done upon marriage, but can also happen before. The married son who receives the land is obliged to give a certain share of the land to his wife such that marriage guarantees access to land for women. Therefore, within marriage, women have relatively secure land rights. However, she cannot sell any land received from the family. Women are also excluded from inheriting land. Even though the Kenyan law has by now legalized the bequest of land to daughters, most family elders continue to give the land exclusively to sons (Davison 1988).

Under the British colonial rule, land entitlements have been introduced in the course of the Swynnerton Plan that came into law in 1954. The major aim of the plan was to reform land ownership system by introducing a formal land entitlement system that induces agricultural development through setting proper incentives.[3] A result of this effort was that many men took the chance to register all family land in their names. Even though, their wives were formerly granted land for cultivation, women had no possibility to claim that land legally.

As noted, within marriage, women's access to land is secure and land cannot be taken away by the husband. The woman also often exercises the right to control the produce of the land and to decide what to

3. [3] Although the Swynnerton plan was launched in 1954, its implementation is still ongoing as a lot of land has not yet been registered.

crop and what to sell. Hence, as long as the conjugal arrangement holds, land rights are well defined, but if marriage ends, the woman's access to land is at risk. In case of separation or death of the husband, the family of the husband often claims back the land which they have initially given to their son. This may even happen years after the passing of the man, in case he had a younger brother and the parents become in need to give out land. However, if the woman happens to become a widow, often a brother of the deceased husband takes over farm decision making. `Formally', the husband's family therefore still holds the land rights, but for the widow this implies that she is granted a means of survival, for the brother as the `representative' decision maker guarantees that she can keep the land (Davison 1988).

In some other cases, the widow or separated woman may cultivate the land on behalf of one of her sons or brothers, which puts her into the same position as if a relative of the passed husband took over decision making power. Unmarried women may receive land from their father which enables these women to form an independent household. However, these women may not have control rights over the land because the father often keeps control such that in case one of his sons marries, he still has land at his disposal to give to his son (Davison 1988, Yngstrom 2002). Men on the other hand do not face such difficulties as tenure insecurity as they are favored through the traditional land distribution system.

Although the examples bear some specificity for Kenya, it is easy to find examples from other ethnic groups other than the Kikuyu either in Kenya or other Eastern African countries where mechanisms of land allotment and marriage are very similar (for further examples and references see Davison 1988, Gopal amd Salim 1998, Yngstrom 2002). The constraints of widows bear similarity to those women left by their husbands (Gopal and Salim 1998). However, women may also seek divorce. This decision may be driven by the consideration that she can achieve a higher level of welfare outside marriage. Using data from Jamaica, (Handa 1996) finds that some women gain more from staying unmarried since they have independent access to resources. Regarding divorce, women may seek separation only when having secure access to land and exerting full decision making power.

Another widespread phenomenon is the temporary out-migration of husbands seeking employment in urban areas. In Uganda it has been found that husbands---although absent---maintain the decision making power even when they are away from home over extended periods. Asked why they did not apply improved farming technologies, the women responded that they do not have the right to make decisions about investments (Kennedy and Peters 1992). In these households, men often still play a dominant role in household decision making while the woman is not allowed to decide about important on-farm investments.

The examples cited provide a guideline for constructing different classes of FHH according to their marital status and the presence of a man who affects household decisions and determines tenure security. A widow who receives support from her sons is not exposed to the same constraints as a widow who needs to argue with her husband's family about the land. A FHH which emerged out of temporary outmigration is cropping under different constraints when the man still keeps the right for on-farm decision making compared to a fully responsible woman. All these different situations imply different constraints which affect agricultural production and thus lead to varying levels of productivity. The model developed in the next section aims to account for the heterogeneity of FHH while explaining the observed ambiguity of productivity levels of FHH.

III. THE MODEL

In order to derive the conditions under which FHH exhibit either higher, equal, or lower levels of productivity compared with MHH, I construct a household optimization model that allows for investigating labor supply decisions under two different states. The one state is achieved when the household's income is above the subjective poverty line. In this case, the standard model as the one by Sandmo predicts that risk averse farmers would reduce labor supply when exposed to tenure uncertainty. On the other hand, in the second state, farmers face the risk of falling below the poverty line that changes their response to tenure uncertainty. Reducing effort is not an option as it would imply becoming even poorer and

more deprived. In order to escape that trap, farmers need to increase effort to avoid becoming poorer. A major result of the model developed below is therefore that tenure insecurity does not necessarily lead to a reduction of labor supply, depending on which perception of risk prevails: (i) tenure uncertainty or (ii) the risk of falling short of income. The model is kept simple and considers only labor as an essential variable input. However, the model is generalizable to all other inputs such as fertilizer, pesticides or draft power as well. Land, the second important input, is considered fixed throughout the following analysis.

I begin with a simple framework in which utility is maximized under perfect security, which will be extended later in the text. The farmer is endowed with a fixed amount of labor time T which she allocates across two different income generating activities: crop cultivation and off-farm work. If the farmer has the opportunity to generate off-farm income she receives a wage rate w so that her off-farm income will be wl, where l denotes her off-farm labor supply. This activity does not need to be restricted to denote only wage labor, but w may also represent marginal returns to off-farm enterprises. Land A is cultivated using labor T-l which gives rise to a production function of the form $q = f(T\text{-}l,A)$ for which it is assumed that $f' > 0$ and $f'' < 0$, where f' and f'' denote the first and second derivative of f with respect to l. Each activity of the woman involves a cost which is captured by a function c_w and c_f respectively, which share the usual properties of a cost function, that is $c' > 0$ and $c'' > 0$. The costs arise from the disutility of labor. Alternatively, one may think of more sophisticated representations where the costs in c_w arise from purchasing inputs for off-farm enterprises, from searching for a job, transportation, etc. Equivalently, one may extend c_f to include the needs to purchase seeds, fertilizer or pesticides without substantial complication and without changing the basic results. However, for reasons of simplicity I focus on labor supply only and thus the only variable driving the cost function is l. Combining productive activities with the cost functions, the woman faces an income given by

$$y = wl - c_w(l) + f(T\text{-}l, A) - c_f(T\text{-}l) \qquad (1)$$

This equation describes the situation of a farmer who does not encounter any constraints other than her disutility and restrictions implied by wage rates and the technology applied. To capture tenure insecurity, let $\pi(\theta)$ be the probability that the farmer can retain the benefits from labor supply (or investments) in future periods. From π, we obtain expected returns from farming by

$$E(f(T\text{-}l, A)) = \pi(\theta) \cdot f(T\text{-}l, A) + (1 - \pi(\theta)) \cdot 0 \qquad (2)$$

The probability π or the level of tenure security depends on the woman's level of bargaining power as she needs to defend her land against the claims of her husband's family. It is convenient for the subsequent analysis to assume that the bargaining power parameter θ directly translates into π such that $\theta = \pi$. If the woman has the means to defend the land against claims of her husband's family, that is, if θ is equal to or close to 1, then she faces a high level of tenure security. Note that in the present framework π does not necessarily need to represent tenure security, but may equally denote the power to make on-farm investment decisions in case of absent husbands. In this regard, θ can also be interpreted as the power to exert the right to decide.

The second modification concerns the probability that households only achieve a level of income below the poverty line. Very poor households need to define an income target that ensures a minimum welfare level, such as the satisfaction of a minimum level of nutrition, basic needs, etc. This income target is somewhat different from the usual notion of an income target that implies a backward bending labor supply curve where the target works as a threshold. In target income models, workers do not want to supply more labor, but value leisure higher than additional income, once the threshold has been achieved.[4] In the present setting, target income rather refers to a different concept, that is, farmers facing the risk of not achieving their minimum acceptable income, supply more labor in order to get as close as possible to the income target. Hence, households at risk of falling below their income target cannot afford to work less and thus exhibit a different cost function as compared

4. [4] See Camerer et al. (1997) and Farber (2005) for investigations on target incomes and labor supply.

to a wealthy household. Obviously, the probability that a woman achieves her target is a function of available income and is denoted by $p(y)$.

Since y is a function of available land size A, returns from market labor w, total availability of labor time T, but also of bargaining power θ, we can write p equivalently as $p(A,w,T, \theta)$. p is the realization of a cumulative distribution function and is assumed to be increasing in all of its arguments. For instance, with rising wage rates, income increases as well as more labor is allocated to off-farm activities, which in turn increases the probability to achieve the income target. In the model below, the variable p affects the shape of the cost functions which flatten when p approaches zero.

Combining tenure insecurity and the probability to achieve the income target with (1) and maximizing with respect to labor yields

$$w = pc_w' + (\theta f' - pc_f') \qquad (3)$$

Women allocate labor such that the going market wage rate equals the marginal cost of working plus the difference between marginal returns from labor and the marginal costs from farming. After solving for l, optimal labor supply can be expressed as a function of θ and p, as well as of A and w. Denote optimal labor supply as $l^*(\theta, p, A, w)$. Applying the envelope theorem with respect to θ gives

$$\frac{\partial l^*}{\partial \theta} = \frac{f' - p'c_f' + p'c_w'}{\theta f'' - p'c_f'' - p'c_w''} < 0 \qquad (4)$$

since the numerator of the right hand side is positive as it is a scaled version of the right hand side of (3) which is positive, since $0 < p' < 1$. The denominator is negative, because $f'' < 0$, $c_f'' > 0$, $c_w'' > 0$ and thus (4) follows. Since l^* represents optimal off-farm labor supply, the negative sign of (4) implies that FHH increase farm labor once the level of tenure security improves. The results demonstrate that land is underutilized as long as income from farming is insecure.

Since l^* represents optimal off-farm labor supply, the negative sign of (4) implies that FHH increase farm labor once the level of tenure security improves. The results demonstrate that land is underutilized as long as income from farming is insecure. Labor is allocated until the farmer's marginal productivity equals her marginal costs. If tenure is insecure, that is, when $\theta<1$, expected output decreases while generating a new production frontier which is illustrated by the lower dashed concave curve. As a response to lower expected returns, the farmer reduces labor supply until marginal productivity and marginal cost are just equal. This reduction of effort results in an accompanying decrease of output from q.

However, if p decreases—e.g. due to a decrease of off-farm income— labor supply is increased in order to secure the achievement of the income target. The comparative statics regarding the change of the return from off-farm employment reveal

$$\frac{\partial l^*}{\partial w} = \frac{1 + p'c'_f - p'c'_w}{p'c'_w - p'c'_f - \theta f''} \qquad (5)$$

Expression (5) is positive as long as the marginal disutility of labor in farming c'_f is larger than the marginal disutility from working on the labor market c'_w. This holds when labor markets are underdeveloped or wage rates are low, which are the cases I am focusing on. A positive sign of (???) implies that labor is withdrawn from agriculture and allocated to off-farm activities if the wage rate is rising. With no other options but farming available, households would employ all labor in agriculture yielding the first order conditions

$$\theta f' = pc'_f \qquad (6)$$

In order to analyze the impact of p and θ on farming efficiency, I focus on farming only and investigate the effects of farm labor supply in response to varying θ and p while holding all other factors fixed. To facilitate the exposition, I focus on equation (6) and neglect for simplicity the existence of labor markets. It should be noted that the general result is not affected by this simplification. However, later I introduce off-farm activities through investigating the effect of variations of the wage rate w on p. The crucial assumption is that p increases with w, which implies that households reallocate more and more labor towards the generation of income from off-farm activities. To see how labor allocation and

productivity is determined, I consider four cases summarized in table 1.

Table 1 Different cases with missing labor markets

Case 1	$f' = c_f$	$\theta = 1;\ p = 1$	Average efficiency
Case 2	$\theta f' = c_f$	$\theta < 1;\ p = 1$	Below average efficiency
Case 3	$f' = pc_f$	$\theta = 1;\ p < 1$	Above average efficiency
Case 4	$\theta = pc_f$	$\theta < 1;\ p < 1$	Indeterminate

In case 1, the woman has achieved full tenure security and achieves target income with probability 1. That is, wage rates or land size are large enough to ensure that p=1. In this case, household production is only constrained by personal disutility of labor and the household achieves average levels of productivity. Case 2 refers to women for whom tenure is insecure, implying that labor supply is below average. The FHH allocates labor such that the marginal productivity of farming equals the marginal cost. But since θ<1, the expected marginal returns are lower compared to case 1 households, implying that marginal costs must be lower as well. Consequently case 2 households exhibit a lower supply of labor and therefore lower output. In case 3, the curvature of the cost function is flattened through the impact of the low probability to achieve the income target. Hence, labor supply must be above average and, given land and labor time T, the household produces more than a case 1 household. Finally, in case 4 both factors, tenure insecurity and low probability to achieve target income, affect labor supply decisions. The location of these households relative to the efficiency frontier depends on the curvature of the production and cost functions which is determined by θ and p. This implies that empirically this case cannot be distinguished from the other three cases when only production output is observed. Given the shape of the two functions, labor supply might be above, below or even exactly equal to case 1 households. An appealing feature of the model as summarized by the four cases is that it allows for explaining different levels of productivity even in the absence of labor markets.

The four cases in table 1 further imply another result: with increasing w, p increases as well and the impact of tenure insecurity in case 4 becomes stronger. To see this, consider the production outcome q_m, which is the level of production of a case 4 household and define the production outcomes q_u and q_l for case 2 and case 3 as upper and lower bounds respectively. Since in households for which case 4 applies θ<1 and p<1 the household's production outcome q_m is located somewhere between q_u and q_l. But with increasing p, the case 4 household approaches and eventually transforms into a case 2 household. Consequently, q_m approaches q_u which is associated with case 2 households; household production declines. The opposite case can be constructed when p is kept fixed and one allows θ to increase.

The model shows that the farmer's response to tenure insecurity is state dependent. When the farmer faces the risk of an income shortfall, the effect of tenure insecurity is overcompensated by the effect of p and output may not be decreased at all or may even be higher as in households exhibiting the same levels of θ but large values of p. For relatively wealthier farmers, there is only a small risk of becoming poorer, which why tenure insecurity exerts its full effect in decreasing production. That is, with given bargaining power θ and given probability p to achieve target income, FHH are either more, equally or less efficient compared to a MHH.[5] Using the model it is possible to explain the seemingly contradicting findings from the various empirical studies that have been concerned with agricultural production and the comparison of FHH and MHH. These findings have implications for empirical studies as well: the different states can only be identified when the levels of θ and p are appropriately controlled for.

IV. THE DATA

The data used in this study stems from the Kenyan Welfare Monitoring Survey III, which has been conducted during 1997 and covers more than 11,000 households. However, due to a large number of missing responses on agricultural inputs and urban

[5] In principal it is possible that a MHH correspond to a case 1 or case 3 household. However, it is assumed that there is no characteristic other than low off-farm incomes that is systematically related to case 3. So, when joining all MHH within a single category, MHH must be on average more productive compared to a FHH to which case 3 applies.

households not engaged in agriculture, the total sample size reduces to 4,088 observations. The FHH indicator builds on self-reported headship to achieve comparability with other studies. The data allows for distinguishing different categories of FHH according to the three criteria (i) marital status, (ii) demographic characteristics and (iii) main household decision maker. Marital status, which is a standard question in most large scale household surveys, is probably the most obvious feature to categorize FHH. The questionnaire includes the categories married, never married, widowed, divorced or separated, and whether the household is part of a polygamous household compound. In almost all households of the married category, no husband is currently staying at home and thus these are named henceforth *Temporary*. A second category covered by the data is whether the woman is divorced or separated. For this category it would be desirable to know who initiated the separation as it may affect the results, since women who seek divorce may be well prepared to live outside the household (e.g. through land ownership, wage employment, etc.). Women who have been left by their partners might be in a much less favorable situation (Gopal and Salim 1998). Divorced women are termed *Divorced*. The next category consists of widows and is named accordingly. Women who have never been married are called *Single* and finally women from polygamous households are classified under the heading *Polygamous*. It would be desirable to distinguish single women according to their choice of being unmarried, that is, whether land endowment has influenced the choice not to marry. Although, of the single women in the sample, only four indicate that a male non-relative resides permanently in the household, this does not imply that these women do not have a male partner. The partner may just not live with the woman in the same household.

The final characteristic used for classifying FHH refers to the main household decision maker, which determines the categories *de jure* and *de facto* FHH, whereas in the former category, women are considered as having control over household decisions while the de facto category denotes FHH in which not the woman does on-farm decisions but a male relative. The questionnaire contains a question on who decides on farm investments. The answer is taken here as an indication of the true head of household: FHH where the woman is responsible for farm investments are allocated into the *de jure* category and classified as *de facto* otherwise. Note, that these categories do not immediately imply the status of bargaining power, which is determined only in combination with marital status. In total, eight different categories emerge from applying these categories to the data. The different classes mainly arise from distinguishing the marital status with respect to *de jure* or de facto FHH. To facilitate exposition the categories are abbreviated *DJ* and *DF* respectively.[6] Only unmarried and polygamous households are treated as special cases and are not further categorized according to the decision maker.

The meaning of the terms *de jure* and *de facto* FHH as applied in this study does not entirely correspond to its common use (see Kennedy and Peters (1992) for an early application). The category de jure is usually used to classify widows, divorced and separated, as well as single FHH, while de facto refers to households where the woman is married but her husband is mostly not present. However, the terms are used here to further distinguish these FHH categories, as the sole application of the de jure and de facto categories fall short of fully capturing the true household decision maker.

Finally, it is necessary to analyze the levels of bargaining power of the women from the respective household categories. As in the previous section, the term bargaining power is only used for brevity and should not be taken literally, as *DF Temporary* are not threatened to lose their land, but are characterized by low levels of decision making power. Since the absent husbands still aim to control farm investments, these households are characterized by low levels of bargaining power. *DJ Temporary* households on the opposite fully control farm investments and hence exhibit high levels of θ. Among widows, those with male support, that is, where a male relative has the principal right to decide on farm investments, have a

5. [6] There are 28 households in the DF Temporary category who indicate that a husband is present. This seems to be unusual and may be the result of misreporting. Excluding these household leaves the results unchanged. When forming an extra category of these households, the new category exhibits the same signs and levels of significance as the DF Temporary category. I therefore decided to keep these households as DF Temporary.

better bargaining position than their counterparts, where the woman is fully on her own. Thus, *DF Widows* have high levels of bargaining power while *DJ Widows* are at permanent risk that the husband's family claims back the land.

V. EMPIRICS

The goal of the empirical analysis is to detect different levels of productivity among FHH which point to different exposure to tenure insecurity and low levels of decision making power. I first estimate the efficiency frontier using a variable cost function and in a second step investigate whether deviations from the frontier are systematically related to different kinds of FHH. Tenure insecurity is determined by the household's level of bargaining power, which is shown for each household type in table \ref{signs where the first column is repeated from table \ref{bargaining to facilitate the exposition of the empirical strategy. To determine where households are located relative to the efficiency frontier, a dummy variable is introduced into the cost function that accounts for each FHH category. A significant dummy implies a shift of that household category either closer to or further away from the efficiency frontier as compared to the average MHH. Given the estimation approach employed and described below, a negative result implies higher efficiency scores while a positive parameter indicates that the respective household is less productive.

Furthermore, the empirical exercise aims to discover state dependent responses to insecurity. The fundamental result of the model is that tenure insecurity exerts a different effect in each regime with implications for labor supply and productivity. Also, for households with perfect security the different regimes have efficiency implications as is evident from cases 3 and 1. The regime is determined by p, which represents the risk of falling short of income. The level of p is measured by the level of off-farm income generated by the respective household. The off-farm income is interacted with the dummy in order to determine the category specific effect. Its interpretation is simple: when the sign is significantly positive, then with increasing income the levels of farm inefficiency increase as well because households allocate more labor away from farming toward off-farm activities. This implies an undercultivation of the available land and thus increasing inefficiency.

To be able to interpret the results, it is necessary to clarify the possible assignment of households to the four cases. Column 3 of table \ref{signs gives an account of which FHH category can be assigned to which case. The table further contains in column 4 and 5 the signs of the dummy variables that are conform to the predictions of the theory developed in the previous chapter. By the definition of the FHH categories, the only households facing low levels of θ are *DF Temporary* and *DJ Widow* households. This implies that these households can be assigned to either case 2 or case 4. Hence, based on the theory one would expect these two household categories to be more, equally or less efficient compared to MHH, when controlling for all other determinants of productivity. Which one of these three possibilities hold is an empirical question. When the sign is negative, the household belongs to case 4 because this is the only one of the two cases that allows above average levels of productivity (see table \ref{cases). When the coefficient is insignificant, the household may also be a case 4 household due to the same reason, as the effects from θ and p may just neutralize each other.[7] When the sign of the dummy turns out to be significantly positive it is not possible to unambiguously assign the households to case 4 or case 2 as both cases allow for this option. However, as explained below, the information from the interaction term can be used to recover the case to which the household category belongs to.

DJ Temporary and *DF Widow* households are expected to be either equal to a case 1 or case 3 household as tenure insecurity does not affect them because of their high levels of bargaining power. The theory predicts that these households are either more or equally productive compared to average MHH, depending on the perception of income risk. Estimates of levels of productivity for this class of FHH are therefore predicted to be either negative or insignificant. A negative estimate means that these households are more productive than average MHH

6. [7] An insignificant parameter may also imply that neither tenure insecurity nor low levels of p determine productive outcomes.

and thus are assigned to case 3. An insignificant parameter implies that there is no difference to the average MHH which is assumed to be equivalent to a case 1 household. Since it is unknown whether the remaining four FHH categories have on average a high or low value of θ no expectations can be formulated beforehand.

The theory further implies that households which are initially case 3 or case 4 households can transform into case 1 and case 2 households respectively. That is, with increasing off-farm income, p is increasing and case 3 and 4 households eventually switch from one state into another. As laid out above, whether such transition exists is tested via the inclusion of an interaction term where off-farm income is interacted with each FHH category. Here again, the model implies some restrictions. Transiting from one state into another implies that households which have initially been a case 3 or case 4 household must become more inefficient with increasing incomes. That is, if a transition occurs, then the interaction term must be positive, meaning that when off-farm income activities become more attractive, more labor is allocated away from farming toward the off-farm income activity and levels of productivity decrease.

However, the theory offers even more restrictions: *DJ Temporary* and *DF Widow* can only exhibit a transition from case 3 to case 1 if case 3 households exist at all. This can easily be checked by referring to the dummy variable estimate of these households. If the dummy does not become significantly negative, there are no case 3 households and a transition cannot occur. For *DF Temporary* and *DJ Widow* this restriction does not hold, since the insignificance of the productivity estimate still does not exclude these categories from being case 4 households. However, if a transition occurs, that is, the interaction term becomes significantly positive, then an insignificant dummy variable unambiguously implies a case 4 household.

A problem inherent to the empirical implementation of production functions in the context of cross-sectional household data is recursive causality. In most production settings, the input quantities must be considered as choice variables, because input quantities are chosen on past experience and thus on expected output. This implies that the choice of input quantities is not independent of the level of output. However, in this case, inputs are correlated with the error term. The same can be expected for all variable inputs where the decision on the quantities is likely to be determined by the expected amount or past realizations of output. Therefore, estimates from a production function using cross-sectional data should be treated with caution as the parameters are likely to be inconsistent due to the endogeneity of the independent variables (see Griliches and Mairesse (1998) for an extensive account of the problems involved when estimating production functions using cross sectional data).

The problem of endogeneity can be circumvented by estimating a cost function rather than a production function. When the optimization problem of the producer is reformulated such that the agent minimizes costs, given input prices, output quantities and a production technology, a cost function results. Under the assumption that farmers are price takers on a competitive market, output quantities are assumed to be exogenously given since in a competitive market the farmer chooses his output based on output prices which are exogenous as well (Jorgenson 1986). The fundamental result of duality theory is that the cost function is the dual formulation of the production function, that is, the same optimizing behavior leads to the same outcomes: minimizing costs at given prices implies maximizing production at given inputs Under the assumption that the farm-households are price takers, all input prices can be treated as exogenous.

Productivity or efficiency can be decomposed into technical and allocative efficiency. However, the predictions based on the theoretical model developed in the previous section do not distinguish between the two kinds of efficiency. Higher productivity and output may be achieved by either better usage of existing inputs or by using more of one input. Therefore, to investigate the empirical content of the model, an approach is needed that can handle both technical and allocative efficiency. Other than the production function approach, the efficiency measurement embedded into a cost function is capable of capturing technical and allocative efficiency. A further advantage of the cost function is that it easily accommodates multi-output production schemes

which is particularly relevant for societies dominated by agriculture as it is the case in Kenya. \newline

In this study I focus on smallholder farming and exclude large commercial farms as these can be assumed to produce with a technology which is likely to differ substantially from those of the smallscale farmers. The median size of a smallscale farm in the sample is 3 hectares. All farms larger than the 95th percentile (22.5 hectares) are treated as large scale farms and are excluded from the sample.

Prices are available for hired labor and draft power. Prices for family labor are computed by the approach suggested by Jacoby (1993) and Skoufias (1994) while using the number of household members working in farming. Estimating family shadow wages is necessary in order to account for the observed difference between market wages and the family shadow price for labor (Menon et al. 2005). The data also contains information on hourly labor supply, but this data is considered extremely noisy as it is based on recall and is subject to a large number of missing cases. Furthermore, it covers only a week and does not account for any seasonal variations. Land is considered fixed, which is a reasonable assumption as land markets are largely unavailable in rural Kenya. I further consider fertilizer, pesticides and manure used, for which dummy variables are included when the respective input has been applied.

Since most households plant a relatively large portfolio of different crops, the output quantities are divided into three major output classes: maize and cereals, vegetables and fruits, and cash crops. As further controls for the choice of technology, I include a dummy for the educational background of the head of household (primary and secondary schooling) as well as dummy variables indicating whether the household applies labor intensive irrigation. Furthermore, a dummy has been included for households which have been visited by an extension agent. A translog variable cost function is applied with the usual constraint imposed.

VI. RESULTS

The cost function is estimated using a stochastic frontier approach, which has been established as a standard tool for investigating the production of cost efficiency (Kumbhakar and Lovell 2000). The stochastic frontier approach aims at estimating a cost or production frontier and to determine the distance of each farmer from the efficiency frontier. The empirical model is specified as

$$\ln \mathrm{VC} = \mathrm{f}(\mathbf{P}, \mathbf{Q}, \mathbf{Y}) + v + u \qquad (5)$$

where $f(\cdot)$ has a translog functional form and its arguments refer to prices, fixed inputs and output respectively. v denotes a random component assumed to be distributed as $v \sim N(0, \sigma^2)$ and u is a systematic measure of cost efficiency for which $u > 0$ must hold. Negative values for u are prohibited since it is assumed that producers do not produce at negative costs. The interpretation of the efficiency measure u is simple: since $f(\cdot)$ represents the efficiency frontier large values of u imply large deviations from $f(\cdot)$ and therefore high levels of inefficiency. Since u cannot become negative it needs to be modelled using an asymmetric distribution. The likelihood function constructed here is based on the exponential distribution, which is an asymmetric distribution and has achieved standard usage beside the half normal distribution.

The efficiency measure is modelled as

$$u = \alpha + \delta' \mathrm{x} + \eta \qquad (6)$$

where x consists of (i) the FHH dummy indicators and (ii) the set of interaction terms, where income from other sources than farming is interacted with the FHH dummies to account for household specific levels of p. Off-farm activities include income from wage labor, profits from business and remittances. The properties of the measure of inefficiency imply that negative parameter estimates for δ are associated with greater efficiency.

After inserting model (6) is inserted into (5) the model is estimated, the parameters of which are presented in table ??? The parameter of *DJ Widow* is negative and significant at the 5 percent level indicating that the average state of the household after controlling for alternative sources of income corresponds to case 4. The negative sign implies that given land endowments and prices {*DJ Widow* households are on average more efficient compared to

MHH. The coefficients of all other household categories do not achieve any usual level of significance. {*DJ Widow* households are therefore not only more productive than MHH but also compared to the remaining FHH categories as well. Regarding case 4, the negative sign implies that the probability that these households are threatened by shortfalls of income and thus need to achieve higher levels of productivity is higher as compared to the other household categories. Since neither {*DF Widows* nor {*DJ Temporary* households are affected by low bargaining power, case 4 is ruled out and thus these households must be assigned to case 1. For the other for FHH categories it is not possible to determine the level of bargaining power beforehand, making it impossible to draw unambiguous conclusions. These household categories may either be equal to case 1 or case 4 households.

Table 2 Estimated parameters

Dummy variables		
DJ Temporary	0.016	0.259
DF Temporary	-0.044	-0.978
DJ Widow	-0.094**	-2.09
DF Widow	-0.033	-0.82
DJ Divorce	-0.034	0.708
DF Divorce	0.118	1.379
Single	0.147	-0.200
Polygamous	-0.043	-0.711
Interaction terms		
DJ Temporary	0.024	1.339
DF Temporary	0.034**	2.93
DJ Widow	0.038**	2.62
DF Widow	-0.002	0.202
DJ Divorce	-0.03	-0.52
DF Divorce	-0.005	-0.183
Single	0.029	0.638
Polygamous	-0.013	-0.788

Numbers in the second column refer to the parameters and the third column to associated t-values.

The interaction term for *DF Temporary* is significant and positive indicating that the low decision making competence increases farm inefficiency as soon as income from other sources rises. This result suggests a transition of {*DF Temporary* households from case 4 to case 2. The insignificant parameter for the dummy variable may thus be interpreted such that in the first stage {*DF Temporary* households correspond to case 4 where the effects induced by p and θ neutralize each other, that is, the positive productivity effect emerging from low values of p is compensated by the negative efficiency impact that arises from low values of θ. {*DJ Widow* households reveal a significantly positive parameter for the interaction term, too. Both cases are conform to the hypotheses that the negative impact of tenure insecurity on farming becomes increasingly apparent with rising p. However, tenure insecurity affects only households where women are left with low decision making power or where they are threatened of losing their land, that is, only households facing low levels of θ exhibit increasing inefficiency with rising off-farm incomes. All other households just achieve the same levels of average efficiency that characterizes MHH.

VII. CONCLUSIONS

In this paper I have investigated the interrelatedness of response to tenure insecurity (and low decision power) and income risk. The results suggest that depending on which of these risks prevails, FHH are either less, equally or more productive compared to MHH. If the connection between these risks is not appropriately controlled for, empirical analysis would yield biased results. For the case of Kenya, FHH would seem equally productive compared to MHH and tenure insecurity would not appear to play a role in labor allocation decisions. Previous studies on this issue finding that FHH turn out to be even more productive (e.g. Moock 1976) do not offer an explanation for this finding and also seem to suggest that FHH fare better compared to MHH. However, the model developed in this paper shows that households are only more efficient when facing income risks and thus allows for explaining higher levels of productivity of FHH. Furthermore, the model allows to reconcile the finding of higher levels of productivity among FHH with the often repeated result that FHH are

actually less productive, through integrating the concepts of income risk and tenure insecurity. Judging from the empirical results, both risks seem to be credible and FHH respond to them.

A second important result that came up in this study is that FHH categories are significantly different from each other, such that, when FHH are joined into a single household category, any analysis of productivity in rural areas falls short of capturing the specific constraints each of these household categories is facing. The results imply that tenure insecurity and the lacking ability to decide on investments are visible in only a few categories, revealing an impact on productivity in two household categories only. The findings are consistent with the assumption that male influence or bargaining power appears to be a factor that determines household production decisions. It is interesting to note that even within seemingly homogeneous categories like widows, divorced or temporary FHH there are significant differences. The findings suggest that a rethinking of the concept of FHH with regard to production and access to resources, but possibly also in the context of welfare, time use etc. would help to uncover structural discrimination and its sources.

The results point to the potential underestimation of the negative effects arising from tenure security when the FHH category specific constraints are not controlled for. This finding suggests that in previous studies the effect of tenure insecurity may turn out to be too low, which emphasizes the need and again raises the question for secure land right regimes for women and men. Only the granting of secure access to productive resources is a viable means to improve productivity of women farmers in the long run. Insecure access to land has further implications as in rural areas it directly translates into the impossibility to obtain credits and to expand into further income generating activities. The finding that some FHH achieve higher production efficiency does not invalidate the necessity of targeted programs for women, but in view of the theory call for a refinement of the legal system and the status of women.

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