Women's Access to Credit: Does It Matter for Household Efficiency?

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Studies that assess the impact of credit constraints on farm households' efficiency have largely used the household as the unit of analysis. This can be problematic when there are gender-based market imperfections and asymmetries in how rights, resources, and responsibilities are distributed within the household. Constraints on women matter: in addition to the efficiency loss associated with the husbands' credit constraints, when women are unable to meet their needs for capital, their households experienced an additional 11% drop in efficiency. This suggests that there are efficiency-based arguments for enhancing women's access to capital and that studies based only on the household's head may significantly underestimate the true economic impact of credit constraints.

Key words: constraints, credit, efficiency, intrahousehold, Paraguay, women.

Improving poor households' access to capital is a common element of rural strategies that are designed to induce growth. Economic theory predicts that by relaxing the liquidity constraints of poor households, interventions that enhance these households' access to capital will lead to a more efficient allocation of resources, increased production, and higher welfare (Singh, Squire, and Strauss 1986). A number of researchers have sought to inform this claim with empirical data by assessing the negative impact of credit constraints on farms' and households' efficiency (see for instance, Feder et al. 1990; Ray and Bhadra 1993; Carter and Olinto 2003; Foltz 2004; Petrick 2004; Chavas, Petrie, and Roth 2005; de Mel, McKenzie, and Woodruff 2007; Guirkinger, Fletschner, and Boucher 2007).[1]

By and large, these studies have used the household as the unit of analysis, an approach that can be problematic in settings where there are gender-based market imperfections and significant gender-based asymmetries in how rights, resources, and responsibilities are distributed within the household. Specifically, as has been amply documented in the development literature, rural women are more restricted in their access to and control over land (Agarwal 1994; Deere and Leon 1997, 2001) and capital (Sisto 1996; Ospina 1998; Fletschner 2006), and in the type of entrepreneurial activities in which they can engage given their household roles and social norms (Cain, Khanam, and Nahar 1979; Carney and Watts 1991; Schroeder 1996; Kevane 2004; Fletschner and Carter 2008).

Arguably, using the household as the unit of analysis may still be reasonable if, as most economists implicitly assume, households make Pareto-efficient productive decisions. However, the assumption that family members pull their resources and allocate them to their most efficient use may be incorrect. Intrahousehold dynamics tend to be complex: spouses may hold conflicting preferences, and they may not fully share their labor, assets, or information (Haddad, Hoddinott, and Alderman 1997). When spouses disagree, they may choose to not fully pool their resources even if such decisions lead to a less efficient outcome. In particular, Jones (1983) has found that families in Cameroon could have increased their overall production if the women of the household allocated more of their time to rice cultivation, the income from which typically accrues to the men; and Udry (1994) has found that households in Burkina Faso could have increased their level of production

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[1] In parallel considerable work has been done to better understand which households are likely to be credit constrained and the severity of different rationing mechanisms (see Petrick 2005 for a recent overview of this work).

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by reallocating labor and fertilizer from men's plots to women's plots.

If household members do not pool or trade resources efficiently, it would be incorrect to assume that husbands with adequate access to capital will help alleviate the gender-specific constraints their wives face in the financial market. In this case interventions that improve women's access to credit are necessary because women tend to have poorer access to resources than men and rationing mechanisms that limit women's access to capital may have substantial economic consequences for their households. In this article I explore the second part of this argument, namely that there may be efficiency gains to be had from specifically enhancing women's productive capacity within the household.

To evaluate this argument, I use data from a survey carried out in 1999, in which husbands and wives[2] from 210 rural households in Paraguay were asked to provide detailed production information and answer a series of qualitative questions designed to assess their individual access to credit. Using this information, I measured households' efficiency and assessed the impact of men's and women's credit constraints on their households' efficiency.

From a methodological perspective this article is in two important ways an improvement over most other studies that have explored how imperfections in the capital market affect efficiency. First, I use qualitative measures that capture whether or not households are *credit constrained* (do they have adequate access to credit?), rather than whether or not they *use credit* (have they taken loans?).[3] Second, and a central argument of this article, I use information on each spouse's *individual* access to credit instead of relying on *households'* access to credit.

The article presents presents empirical support for efficiency-based arguments to enhance women's access to credit. Analysis of the data confirms that households in which women reported not being able to meet their needs for credit are not producing as much as they possibly could. The costs of these constraints to society are substantial: for the average family, the woman's constraints are associated with an 11% loss in efficiency.

[2] While not all couples were married, most were. I have therefore taken the liberty of referring to the interviewees as spouses, husbands and wives to simplify the exposition.

[3] See Diagne and Zeller (2001) for a useful clarification of the distinctions between taking loans, having access to credit, participating in credit programs and being constrained.

The article is organized as follows. I start by presenting a stylized description of farm households' economic decision making. I then explain the methodology employed to measure household efficiency, discuss the variables used to characterize efficiency, and summarize the efficiency measures. I propose a framework to assess the sources of their inefficiency. I identify spouses' credit rationing status and explain how that information can be incorporated in the econometric analysis. I discuss the factors contributing to households' inefficiency, paying special attention to the impact of women's credit constraints. Finally, I present the conclusions.

A Neo-Classical Farm Household Model

Consider a household i in which, following most standard economic models of rural household decision making, the preferences and constraints of spouses m and f are characterized as follows. Spouses have working capital K_i^m and K_i^f, and they each have L units of labor time. The man dedicates all his labor to the production of marketable goods that can either be exchanged or consumed. The woman divides her time between the provision of household services Z_i and the production of marketable goods.[4] Since the provision of household services does not require capital, Z_i can be represented by the number of hours the woman dedicates to the provision of household services.

Spouses allocate their labor and capital (L, $L - Z_i$, K_i^m, K_i^f) to produce farm and nonfarm outputs (F_i^m, F_i^f, N_i^m, N_i^f) according to a technology X that encompasses all the feasible input-output combinations.[5] It is important to note that following Chavas, Petrie, and Roth (2005), I use the household (i.e., farm and nonfarm production) rather than the farm as the relevant unit of analysis. Chavas, Petrie, and Roth demonstrate that evaluating efficiency at

[4] This gender-based specification of spouses' distinct use of their time is consistent with empirical findings that household services such as cooking, childcare, laundry, and cleaning in peasant families are performed solely by women (Restrepo Chebair and Reichmann 1995). In the rural setting covered by this study production spheres are distinctly gender-specific. Men are in charge of tilling, plowing, fumigating, and selling crops to wholesale traders. Women are responsible for the vegetable gardens, most of the animal husbandry and the processing of agricultural or animal products (Fletschner and Ramos 1999).

[5] To simplify the exposition, I omit, for now, other inputs such as land and livestock. However, they are explicitly included in the rest of the analysis.

the farm level is incorrect when input markets are imperfect or when farm and nonfarm activities are based on a common technology. Both of these conditions apply to the rural setting covered in this study: fieldwork observations and survey results described in more detail in later sections of this article confirm considerable nonprice rationing in the credit market and suggest that farm and nonfarm activities are jointly produced, as nonfarm production can be a source of liquidity for farming activities.

In this one-period model households' revenue is calculated by valuing all production at market prices $p^q(F^m + F^f) + p^n(N^m + N^f)$, loans are repaid $(1 + r)(K_i^m + K_i^f)$, and the profit, π_i, is used for consumption of goods G_i.[6] Families' well-being depends on the goods available for consumption and the household services provided by the women and can be represented by a continuously differentiable and quasi-concave utility function $U_i(G_i, Z_i)$. Thus, family i's economic decision-making process can be modeled as

(1)
$$\max_{K_i^m, K_i^f, Z_i} U_i(G_i, Z_i)$$
$$\text{subject to } G_i \le p^q(F^m + F^f) + p^n(N^m + N^f) - (1+r)\left(K_i^m + K_i^f\right)$$
$$\left(K_i^m, K_i^f, L, L - Z_i;\ F_i^m, F_i^f, N_i^m, N_i^f\right) \in X.$$

Families differ in the extent to which they are willing to substitute household services for consumption goods, but for any given level of household services $\bar{Z}_i$, nonsatiation of the utility function implies that household i will maximize its consumption, which is in turn equivalent to maximizing its profit conditional on $\bar{Z}_i$:

(2)
$$\max_{K_i^m, K_i^f} \pi_i\left(K_i^m, K_i^f \mid \bar{Z}_i\right)$$
$$\text{subject to } \pi_i = p^q(F^m + F^f) + p^n(N^m + N^f) - (1+r)\left(K_i^m + K_i^f\right)$$
$$\left(K_i^m, K_i^f, L, L - \bar{Z}_i;\ F_i^m, F_i^f, N_i^m, N_i^f\right) \in X.$$

Equation (2) implies that for a given level of inputs $(L, L - \bar{Z}_i, \bar{K}_i^m, \bar{K}_i^f)$, a household that is maximizing its profit must be allocating these inputs in a way that maximizes its revenues. Such a household is economically efficient: it is producing as much as it is feasible given its resources, market prices, the technology available, and the level of household services it is providing. By definition an economically efficient household is technically and allocatively efficient. It is technically efficient because for a given level of inputs, the household will produce as much output as is feasible with the available technology. It is allocatively efficient because given market prices, it will choose to produce the combination of outputs that maximizes its revenues.

Using production data from rural households in Paraguay, this article tests whether households do in fact make efficient production decisions by evaluating whether, for a given level of household services, households are producing as much as they could. I do so by measuring households' technical, allocative, and economic efficiency using Data Envelope Analysis. The process to measure households' efficiency and the findings are discussed in the next two sections. The remainder of the article is dedicated to exploring sources of households' inefficiencies and specifically assessing the efficiency impact of women's credit constraints.

Measuring Household Efficiency

A production function representing the underlying technology is estimated using households' input and output data, and each household's distance to that frontier is then calculated. There are a number of approaches used to infer the production function. Parametric methods, which were first proposed by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) can be unduly restrictive, as they require assuming a functional form for the production function. In comparison nonparametric approaches are extremely flexible and less likely to create specification errors. On the other hand, nonparametric approaches are deterministic and attribute the entire deviation of an observation from the production frontier to inefficiency, while parametric methods are stochastic and account for noise, exogenous shocks, and measurement errors. No one method clearly dominates the other (Fare, Grosskopf, and Lovell 1985; Lovell 1993).

In the analysis that follows, I have adopted the nonparametric data envelope analysis

[6] I assume no gender-based pricing. Men and women face the same prices when they sell their products, when they purchase goods and when they borrow capital.

technique to evaluate spouses' efficiency by comparing each household to all other households in the sample. Under this approach a household is considered technically efficient if no other household (or combination of households) produces more output with a similar level of inputs (Paris 1991). The combination of technically efficient households defines the production frontier. Families that are not on the production frontier are inefficient since there are others who are able to produce more output with the same resources. An advantage of using an output-based measure of efficiency is that the results will not be affected by imperfections in the factor markets. This approach only requires well-functioning output markets (Chavas, Petrie, and Roth 2005).

Each household's production is characterized by *x, y* and *Z,* representing vectors of *g* inputs and *s* outputs and the hours dedicated to the provision of household services, respectively. The *i* household 's level of technical efficiency is measured by solving

$$
\begin{aligned}
(3)\qquad & \min_{TE_i,\lambda_i} \; TE_i \\
& \textit{subject to} \quad \sum_{t=1}^{T} \lambda_i^t y_t^s \geq \frac{y_i^s}{TE_i} \quad \ldots \forall s \\
& \sum_{t=1}^{T} \lambda_i^t x_t^g \leq x_i^g \quad \ldots \forall g \\
& \lambda_i^t \, (Z_t - Z_i) \geq 0 \quad \ldots \forall t \\
& \sum_{t=1}^{T} \lambda_i^t = 1 \\
& \lambda_i^t \geq 0 \qquad \ldots \forall t.
\end{aligned}
$$

In this linear program household *i* is compared to all T households in the sample, and it is technically efficient ($TE_i = 1$), unless there is a convex combination of other households (fourth constraint) that produces more output than household i (first constraint) without using more inputs (second constraint) and providing at least as many household services (third constraint). If household *i* is technically efficient, $\lambda_i^i = 1$ while $\lambda_i^j = 0, \forall j \neq i$. If household *i* is not efficient, the combination of farms producing more than household i, under equivalent restrictions, is given by all the *j* households, such that $\lambda_i^j > 0$. The constraint $\sum_{t=1}^{T} \lambda_i^t = 1$ guarantees a convex technology (concave production function) and allows for variable returns to scale.

After knowing *i* household's technical efficiency, it is then possible to measure its allocative efficiency. To assess *i* household's allocative efficiency, one has to compare the revenue that household *i* would have obtained with its current allocations if it were technically efficient $[p^q(F^m + F^f) + p^n(N^m + N^f)][1/TE_i]$ to the maximum revenue it could have obtained if it reallocated it resources MR_i. The index of allocative efficiency is given by:

$$
(4)\qquad AE_i = \frac{[p^q(F^m + F^f) + p^n(N^m + N^f)][1/TE_i]}{MR_i}
$$

and the maximum revenue that household *i* could obtain MR_i is calculated by solving:

$$
\begin{aligned}
(5)\qquad & \max_{o_i,\lambda_i} \; MR_i = \sum_s p^s o_i^s \\
& \textit{subject to} \quad \sum_{t=1}^{T} \lambda_i^t y_t^s \geq o_i^s \quad \ldots \forall s \\
& \sum_{t=1}^{T} \lambda_i^t x_t^g \leq x_i^g \quad \ldots \forall g \\
& \lambda_i^t \, (Z_t - Z_i) \geq 0 \quad \ldots \forall t \\
& \sum_{t=1}^{T} \lambda_i^t = 1 \\
& \lambda_i^t \geq 0 \quad \ldots \forall t
\end{aligned}
$$

where once again, household *i* is compared to convex combinations of households (fourth constraint) that are using no more inputs than household *i* (second constraint) and providing at least as many household services (third constraint). The maximum revenue produced by this convex combination of households indicates the maximum household *i* could have produced.

Finally, *i* household's economic efficiency is given by:

$$
(6)\qquad EE_i = TE_i * AE_i.
$$

Households' Efficiency in Rural Paraguay

These efficiency issues are explored using data from surveys administered to a sample of 210 couples in Eastern Paraguay in 1999. The husband and wife in each couple were interviewed separately and asked

Table 1. Descriptive Statistics of Outputs and Inputs Used to Measure Households' Efficiency

	No.Obs.	Mean	Std. Dev.	Min.	Max.
Outputs					
Male farm income (in US$)	209	2,429	2,759	139	21,994
Female farm income (in US$)	210	1,491	1,748	90	16,556
Male nonfarm income (in US$)	123	1,285	2,719	7	18,283
Female nonfarm income (in US$)	68	1,310	1,934	13	11,200
Inputs					
Land (in Ha.)	209	9.5	8.0	0.6	60.0
Inputs (in US$)	209	1,173	2,329	5	17,280
Male family labor (in adults equiv.)	210	1.6	0.8	0.3	6.0
Female family labor (in adults equiv.)	210	1.5	0.8	0.5	4.0
Hired labor (in US$)	124	189	271	2	1,483
Animals (in cattle equivalent)	210	12.0	9.5	0.8	62.1
Household services					
Hours of household services provided by adult women	210	2,127	2,677	104	38,691

Note: Statistics are based only on nonzero observations for each variable.

detailed questions about their farm and nonfarm productions during the 1998–99 agricultural year, about the inputs they had used and how they had allocated their time. The survey also included a series of qualitative questions that were used to infer whether or not each spouse was able to meet his or her needs for capital.

To measure households' efficiency levels, the households surveyed were characterized in terms of four outputs and six inputs and the time that the women in the families dedicated to household services. These variables are:[7]

OUTPUTS:

- Husband's Farm Income and Wife's Farm Income: monetary value of the crops, animals, and extractive products and goods derived from any of the forementioned.[8] Income was assigned to the husband or the wife according to the gender-specific spheres of production described by community members in a series of focus groups and confirmed by survey responses. In general crops, large animals and extractive products fall under the men's economic sphere, while small animals, vegetable gardens, and animal products are in the women's economic sphere.
- Husband's Nonfarm Income and Wife's Nonfarm Income: earnings from wage labor or independent activities, assigned to the husband or the wife based on spouses' responses to the survey.

INPUTS:

- Land: number of hectares controlled by the household.
- Male Household Labor and Female Household Labor: number of male and female household members, measured in adult equivalents.[9]
- Total expenditure in Hired Labor.
- Animals: livestock owned by the household at the beginning of the agricultural year, measured in cattle equivalents.[10]
- Total expenditure in miscellaneous inputs, for example, seeds, chemicals, etc.

HOUSEHOLD SERVICES:

- Number of hours that the adult women in the household spent in household chores during the year as a proxy for the level of household services they provided.

As summarized in the first column of table 2, the efficiency measures suggest significant room for improvement in the households'

[7] Descriptive statistics are presented in table 1.

[8] To avoid double counting, when calculating the gross value of farm output, I subtracted the value of animals purchased during the period covered by the study (Helfand and Levine 2004).

[9] The survey defines household members as those individuals who were permanently living with the family during the 1998–99 agricultural year. Their labor contribution to the household was calculated according to their age and adapted from Deere and de Janvry's (1981) criteria for Peruvian peasants as follows, 15–17 years old: 0.5, 18–59 years old: 1.0, 60–65 years old: 0.8, 66–75 years old: 0.5 and 76–80 years old: 0.3.

[10] The cattle equivalent for each type of animal was calculated based on their relative market prices.

Table 2. Households' Efficiency

		All	Men are Constrained	Men are Unconstrained	Women are Constrained	Women are Unconstrained
Economic efficiency	Mean	0.70	0.68	0.71	0.61	0.73
	Std. Dev.	0.26	0.27	0.26	0.23	0.26
	% Efficient	32	3	29	3	29
Technical efficiency	Mean	0.84	0.82	0.85	0.77	0.86
	Std. Dev.	0.22	0.25	0.21	0.26	0.20
	% Efficient	55	10	45	11	44
Allocative efficiency	Mean	0.82	0.82	0.82	0.80	0.83
	Std. Dev.	0.18	0.15	0.18	0.16	0.18
	% Efficient	32	3	29	3	29
No. of observations		210	35	175	49	161

economic performance; the average level of economic efficiency observed is only 0.70. The results indicate that the inefficiencies are caused both by households' difficulty in reaching their production frontier and by their misallocation of resources: the average levels of technical and allocative efficiencies are 0.84 and 0.82, respectively. The next sections will explore the sources of these inefficiencies and more specifically, the impact if any that women's credit constraints have on households' efficiency.

Econometric Assessment of the Sources of Inefficiency

A number of factors can influence the efficiency with which households allocate their resources; key among them are their endowments of physical and human capital, their managerial ability, their access to well-functioning input and output markets, and spouses' willingness to cooperate with each other. A rigorous analysis that tries to determine the impact of credit market imperfections on households' efficiency must take these other factors into account. To do so, consider the following equation:

$$(7) \qquad EE_i = \alpha + \beta C_i + \partial HH_i + \gamma V_i + \varepsilon_i$$

where the nonrandom component of the household's economic efficiency is explained by the household's credit rationing status C_i and by household- and village-specific characteristics HH_i and V_i. The vector of household characteristics includes: (*a*) the family's wealth and its composition, (*b*) the household's tenure security; (*c*) proxies for the family's human capital, namely, the spouses', age and education, and the gender-specific adult family labor available, and (*d*) proxies for intrahousehold dynamics, namely, the wife's control over financial resources and her bargaining power. The wife's control over financial resources is represented by the proportion of family assets held in small animals.[11] To capture the wife's bargaining power, I include two variables indicating whether the wife is more educated than her husband and whether her parents owned more land than his parents at the time she and her husband moved in together. Five regional dummies control for village-specific characteristics, such as regional variations in weather conditions, soil quality, and access to markets.

Since my primary goal is to assess the impact of women's constraints in the capital market on their households' efficiency, I estimate two different models. The first model, the "*Household Model*" follows the approach taken by most researchers in this field by estimating:

$$(8) \qquad EE_i = \alpha + \beta C_i^m + \partial HH_i + \gamma V_i + \varepsilon_i$$

where $C_i^m$is a dummy that takes the value of one if the husband in household i is credit constrained. In the economic development literature β has been largely interpreted as the efficiency impact of the household's (not just the husband's) limitations in the credit market. The second model, the "*Spouses Model*" explicitly includes the wife's position in the credit market:

$$(9) \qquad EE_i = \alpha + \beta^m C_i^m + \beta^f C_i^f + \partial HH_i + \gamma V_i + \varepsilon_i$$

[11] In this rural setting the proportion of family assets held in small animals may be a proxy, albeit an imperfect one, for wives' control over family assets. In this region decisions related to the use, sale and purchase of land and large animals are typically made by the men, but women tend to be in charge of the smaller animals and of the income these animals generate (Fletschner and Ramos 1999).

where C_i^m is defined as before, and C_i^f is a dummy that takes the value of one when the wife in household i is constrained. This specification allows us to distinguish between the impact of men's and women's credit constraints. More specifically, β^f represents the loss in efficiency that would be expected if the wife is unable to meet her needs for capital, taking into account whether or not her husband had adequate access to credit. If women's restrictions in the capital market do not affect their households' economic efficiency, β^f would be equal to zero.

To evaluate whether and to what extent spouses' constraints in the credit market affect households' efficiency, I first identify who in the household has adequate access to credit and who is constrained.

Identifying Spouses' Credit Rationing Status

The survey instrument used in this study included a set of questions carefully designed to elicit qualitative information that established agents' credit rationing status.[12] Unlike most other studies that interview household heads (typically male household heads), I collected information about both husbands and wives in order to determine each of their positions in the credit market. Spouses were interviewed simultaneously and separately so that they could not hear or influence each other's responses.[13] In an attempt to make both spouses comfortable with the interview process and more willing to share information that could be gender-sensitive, husbands were interviewed by male enumerators while their wives were interviewed by female enumerators.

Husbands and wives were asked about loans that they had obtained from financial institutions during the 1998–99 agricultural year. If they reported having received at least one loan (in cash or kind), they were asked whether they had been able to obtain as much capital (or inputs) as they would have liked to, and if not, why? If on the other hand they reported that they had not received any loan, they were asked whether they had requested one. Those who had applied for a loan were asked why they had not received one. Those who had not applied for one were asked whether they had wanted a loan at the current rates: if so, why they had not applied for one, and if not, why they did not want one.

Based on their responses, husbands and wives were classified individually as either credit constrained or unconstrained. They were considered constrained if during the previous agricultural year they had been unable to obtain the amount they had wished to borrow given the contracts available. That is, if: (*a*) they had asked for a loan and were turned down; or (*b*) they were offered a smaller amount than what they had solicited; or (*c*) they had wanted a loan at the going rates but decided not to apply or requested less than they had wished to borrow because they believed they would not get that amount. Using these criteria, 17% of the men and 23% of the women in the sample were found to be constrained in their access to credit.[14]

Table 2 presents households' efficiency measures, distinguishing between households in which the husbands are credit constrained (column 2) and those in which they reported having adequate access to credit (column 3). Since most empirical work in economics considers husbands as the heads of households and takes their responses regarding their credit rationing status to represent their households' position in the credit market, these are the results that would typically be reported. The figures in columns two and three are consistent with the findings of a number of studies suggesting that imperfections in the credit or capital markets generate inefficiencies (see Aguilar and Bigsten 1993; Ray and Bhadra 1993; Adesina and Djato 1996). Households in which the husbands were constrained appear to be slightly less efficient than those in which husbands were able to meet their needs for capital.

When one considers women's rather than men's access to credit, the pattern that emerges is stronger. A comparison of columns 4 and 5 in table 2 reveals that households in which women were constrained were significantly less efficient than families in which women did meet their needs for capital. The latter were, on

[12] For other examples of this method of eliciting agents' credit rationing status see Boucher, Guirkinger and Tivelli (2006); Gilligan, Harrower and Quisumbing (2005); Mushinski (1999); Barham, Boucher and Carter (1996); and Jappelli (1990).

[13] Posing the questions directly to each spouse rather than relying on one of them to be the informant is important because spouses may not have complete information about one another. Doing separate individual interviews allows them to share with the enumerators information that they may not want their spouses to know.

[14] In the credit rationing literature, this criteria has also been called quantity-rationing, supply-side rationing, or rationing under a restrictive definition (Boucher, Guirkinger and Trivelli 2006; Fletschner 2006; Barham, Boucher and Carter 1996).

average, 12% more economically efficient—that is, achieved noticeably higher levels of output—than families in which women's access to capital was inadequate.

It could be argued that these figures may be capturing the fact that husbands' and wives' ability to meet their own needs for capital are at least somewhat correlated. If a man is credit constrained, his wife is more likely to be constrained as well: they are members of the same household, live in the same village, and may share resources and information.[15] Therefore, a rigorous evaluation of the impact of women's credit constraints on their households' efficiency requires the type of multivariate analysis described in the previous section.

However, in estimating equations (8) and (9), the use of the observed credit rationing regime dummies as explanatory variables could be problematic. A household's credit rationing status is likely to be endogenous, in which case estimates of β, β^m, and β^f in equations (8) and (9) (the coefficients of the observed credit rationing dummies) would be biased. This problem can be addressed by substituting the observed credit rationing regime dummies with instruments that help explain men's and women's credit rationing status but that are not correlated with the error term ε in equations (8) and (9).

Instruments for Spouses' Credit Rationing Status

To predict the probability of credit rationing for each spouse, I estimate the following two probit models:

$$(10)\quad \Pr\left[C_i^m\right] = \eta^m + \eta_{HH}^m HH_i^m + \eta_V^m V_i + \varepsilon_i^m$$
$$\Pr\left[C_i^f\right] = \eta^f + \eta_{HH}^f HH_i^f + \eta_V^f V_i + \varepsilon_i^f .$$

In addition to containing information about the household's physical capital, tenure security, and human capital, the vectors of household characteristics (HH^m and HH^f) also include proxies for the family's credit history, for whether or not the husband supports his wife's participation in economic activities and for the extent to which women in the wife's reference group are engaged in income-generating activities.[16]

In households with a bad credit history, both husbands and wives may face a more limited supply of funds. At the time of the study, women in this region had only recently begun to borrow and therefore did not have an established credit history of their own, but the rate of default among men was high. The household's credit history is therefore characterized by a dummy indicating whether the husband had defaulted on a formal loan prior to the 1998–99 agricultural year.

Intrahousehold dynamics can impact spouses', particularly wives' ability to meet their needs for capital. When husbands oppose their wives' participation in income-generating activities, they may try to limit the working capital available to them by restricting their access to family funds; by making it difficult for them to go to the financial institutions or participate in committee meetings; by not helping them pay membership shares; or by not granting them access to property that can be used as collateral (Fletschner 2006). Whether or not and to what extent husbands are able to enforce their preferences depends on the strength of their relative bargaining power.[17]

Finally, rural women's credit rationing status may be affected by the behavior of their reference groups. Women may not use or have access to the same information channels as men. They will therefore be more likely to learn about the financial options available to them if they know other women who have taken out loans from formal financial institutions. Moreover, women's decisions to engage in entrepreneurial activities may be shaped by their understanding of what their communities prescribe as socially acceptable behavior for women (Fletschner and Carter 2008). Thus, rural women's demand for capital, and consequently their credit rationing status, may be affected by the extent to which women in their reference groups are engaged in entrepreneurial activities.

The marginal effects of all these explanatory variables on the probability of spouses' credit rationing status are reported in table 5. The two most notable findings are that men are more

[15] Yet, intrahousehold financial intermediation is not perfect: 63% of the women who were constrained, and 48% of the men had spouses with adequate access to credit.

[16] The description of the variables and basic statistics are presented in tables 3 and 4.

[17] As argued in Fletschner (2006), if men have sufficiently strong bargaining power, they may be able to impose their preferences, effectively driving their wives' demand for capital to zero.

Table 3. Description of Variables Used for the Econometric Analysis

Variables	Definition
Household wealth and its composition	
Household's wealth	Value of the land the family operates, their physical capital, and of their livestock assets at the beginning of the agricultural year (in 000s of US$)
Liquidity	Value of livestock assets / Household's wealth
Do they own titled land?	(1 = yes, 0 = no)
Human capital	
Husband's (wife's) age	Age of husband (wife) in no. of years
Age oldest spouse	Age of oldest spouse in no. of years
Husband's (wife's) education	No. of years of education of husband (wife)
Spouses' education	Spouses' maximum no. of years of education
Additional male adults	Number of additional male adults
Additional female adults	Number of additional female adults
Credit history	
Has the husband defaulted?	(1 = yes, 0 = no)
Reference group behavior	
Are there Coop. members in her reference group?	(1 = yes, 0 = no)
Proportion of Coop. members in her reference group	Proportion of the women in her reference group who are members of a cooperative, used as a proxy for how common it is for women in her group to be involved in market-oriented activities
Spouses' bargaining power & intrahousehold dynamics	
Wife's share of household's wealth	Value of small animals / Household's wealth
Is wife more educated than husband?	(1 = yes, 0 = no)
Did wife's parents have more land than husband's parents?	Land owned by her parents minus land owned by his parents, when they got together (in hectares)
Does husband oppose?	(1 = yes, 0 = no) The dummy equals 1 if either spouse indicated that the husband does not want his wife to get involved in market-oriented activities or take loans.

likely to be constrained if they had defaulted on loans in the past and that intrahousehold dynamics matter: women are less likely to be credit constrained when they have more control over the household's wealth.[18]

Next, predictions from these two probit models are used to create two instrumental dummy variables $\bar{C}_i^m$ and $\bar{C}_i^f$ that define whether or not the husband and wife in household i are likely to be constrained according to the following rule:

$$(11) \quad \bar{C}_i^m = 1 \; if \; \Pr\left[C_i^m\right] \geq 0.5$$
$$\bar{C}_i^f = 1 \; if \; \Pr\left[C_i^f\right] \geq 0.5.$$

The models' predictions are accurate for 86% of the men and 85% of the women. With these new dummy variables, and recognizing that efficiency measures have an upper bound equal to one, I can now investigate households' economic inefficiency by estimating two tobit models, the *Household Model*:

$$(12) \quad EE_i^* = \alpha + \beta \bar{C}_i^m + \partial HH_i + \gamma V_i + \varepsilon_i,$$
$$EE_i = Min\left(EE_i^*, 1\right)$$

where $\bar{C}_i^m = 1\left(\Pr[C_i^m] \geq 0.5\right)$ and $\Pr[C_i^m] = \eta^m + \eta_{HH}^m HH_i^m + \eta_V^m V_i + \varepsilon_i^m$ and the *Spouses Model*:

$$(13) \quad EE_i^* = \alpha + \beta^m \bar{C}_i^m + \beta^f \bar{C}_i^f + \partial HH_i + \gamma V_i + \varepsilon_i, \; EE_i = Min\left(EE_i^*, 1\right).$$

where $\bar{C}_i^m = 1\left(\Pr\left[C_i^m\right] \geq 0.5\right)$ and

$$\Pr\left[C_i^m\right] = \eta^m + \eta_{HH}^m HH_i^m + \eta_V^m V_i + \varepsilon_i^m; \text{ and,}$$
$$\bar{C}_i^f = 1\left(\Pr\left[C_i^f\right] \geq 0.5\right) \text{ and}$$
$$\Pr\left[C_i^f\right] = \eta^f + \eta_{HH}^f HH_i^f + \eta_V^f V_i + \varepsilon_i^f.$$

The *Household Model* assumes that the husband's credit rationing status captures whether

[18] For a more in-depth discussion of the factors affecting credit rationing status, see Fletschner (2006).

Table 4. Descriptive Statistics of Variables Used for the Econometric Analysis

	Mean	Std. Dev.	Min.	Max.
Household wealth and its composition				
household's wealth	4.159	3.238	0.324	21.844
liquidity	0.444	0.162	0.059	0.863
Do they own titled land?	0.444	0.498	0	1
Human capital				
Husband's age	49.022	11.349	26	78
Wife's age	44.127	11.539	16	72
Age oldest spouse	49.399	11.172	28	78
Husband's education	4.253	2.347	0	16
Wife's education	4.554	2.404	0	15
Spouses' education	5.314	2.304	0	16
Additional male adults	0.410	0.693	0	5
Additional female adults	0.336	0.595	0	3
Credit history				
Has the husband defaulted?	0.375	0.485	0	1
Reference group behavior				
Are there Coop. members in her reference group?	0.345	0.477	0	1
Proportion of Coop. members in her reference group	0.195	0.308	0	1
Spouses' bargaining power & intrahousehold dynamics				
Wife's share of household's wealth	0.313	0.169	0.044	0.863
Is wife more educated than husband?	0.377	0.486	0	1
Did wife's parents have more land than husband's parents?	−6.714	29.827	−300	162
Does husband oppose?	0.419	0.495	0	1
Access to financial market				
Is the husband constrained? (IV)	0.092	0.289	0	1
Is the wife constrained? (IV)	0.164	0.371	0	1
Household efficiency				
Economic efficiency	0.703	0.261	0.198	1
Technical efficiency	0.842	0.215	0.224	1
Allocative efficiency	0.824	0.175	0.290	1

or not the household as a whole has adequate access to credit, whereas the *Spouses Model* uses two variables that explicitly consider each of the spouses' ability to meet their own needs for capital.

In principle these models could be estimated using a full information maximum likelihood (FIML) approach in which the likelihood function to be maximized considers two sample regimes—households that are economically efficient (censored observations) and those with an economic efficiency level of less than one (uncensored observations). However, estimating a model of this nature is very complex—the likelihood function for those in the first regime involves a bivariate cdf and for those in the second regime a trivariate cdf—and is therefore not feasible with a sample of 210 observations (see Lin and Yen 2008 for a thorough presentation of a similar model).

Given the limitations of the sample size, I employ a limited information maximum likelihood (LIML) approach, estimating the model in two steps. In the first step, I estimate the probit models explaining spouses' credit rationing regimes and create the dummy variables $\bar{C}_i^m$ and $\bar{C}_i^f$ as described earlier. In the second step, I estimate the determinants of households' efficiency using the credit rationing variables from the first stage as though they were observed values. Some of the variables that are assumed to affect spouses' credit rationing status in the probit models of the first stage are also expected to influence the household's efficiency levels directly and are therefore included in the second stage. Even if the set of independent variables were exactly identical, the second-stage equation would be identified because the predicted credit rationing status in the first stage reflects nonlinear functions.

The results are presented in table 6. In the first column, I present estimates of the Household Model as a starting point for the analysis.

Table 5. Prediction of Spouses' Credit Rationing Status. Probit Marginal Effects (Evaluated at Mean of the Regressors)

	Probability that Men are Constrained	Probability that Women are Constrained
Household wealth		
Household's wealth	0.006	0.011
Share of household's wealth held as land	−0.469**	−0.024
Share of household's wealth in physical capital	−0.648**	−0.171
Human capital		
Husband's age	0.001	
Husband's education	0.013	
Additional male adults	0.065**	
Wife's age		0.005
Wife's education		0.005
Additional female adults		−0.054
Credit history and access to collateral		
Has the husband defaulted?	0.297***	0.048
Do they own titled land?	−0.009	−0.075
Reference group behavior		
Are there Coop. members in her reference group?		−0.022
Proportion of Coop. members in her reference group		0.207
Intrahousehold dynamics		
Wife's share of household's wealth	−0.223	−0.821***
Is she more educated than him?	0.106	0.141*
Did her parents have more land than his?	0.000	0.001
Does her husband oppose?		−0.067
Village dummies	Included	Included
Constant	−0.117	−0.507
Log Likelihood	−60.276	−75.753
No. of observations: 210		

Note: single(*), double(**), and triple(***) asterisks represent the 10%, 5% and 1% levels of significance, respectively. The regression included interactions between the husband opposition and the bargaining power variables.

Column 2 reflects estimates of the Spouses Model obtained following the LIML approach and using a least square regression for the second step. This allows me to correct the conventional standard errors taking into account the variation introduced in creating the two credit rationing instrumental variables, as shown by Murphy and Toppel (1985). However, the results obtained using OLS are inconsistent because they do not account for the fact that the dependent variable, economic efficiency, is censored at 1. I therefore repeat the analysis using a tobit model for the second step and present those results in the third column of table 6. These estimates are consistent, but correcting their standard errors is difficult.

This same framework is used to analyze the sources of households' technical and allocative efficiency. For each type of efficiency measure, three sets of estimates are presented: the Household Model, the two-step least square Spouses Model and the two-step tobit Spouses Model. Even if the sample size limitation prevented the presentation of the desired FIML results, the two-step least square and tobit estimates together inform our understanding of the factors associated with households' efficiency.

Do Women's Credit Constraints Affect Households' Efficiency?

Results from the *Household Model* suggest that households' economic efficiency vary with the level and composition of their wealth, with their endowment of family labor, with their ownership of titled land, with spouses' bargaining power, and with their access to credit (table 6).[19]

[19] As described earlier, it is important to interpret these figures with caution: the OLS estimates are likely biased (due to censoring bias) and the Tobit standard errors are likely biased (because they are not "corrected").

Table 6. Analysis of Households' Efficiency

	Economic Efficiency			Technical Efficiency			Allocative Efficiency		
	Household Model#	Spouses Model OLS	Spouses Model Tobit#	Household Model#	Spouses Model OLS	Spouses Model Tobit#	Household Model#	Spouses Model OLS	Spouses Model Tobit#
Access to financial market									
Is the husband constrained? (IV)	−0.247***	−0.222***	−0.219***	−0.183***	−0.174***	−0.158***	−0.112**	−0.103**	−0.101**
Is the wife constrained? (IV)		**−0.111***	**−0.109***		**−0.093***	**−0.104****		**−0.031**	**−0.039**
Household wealth and its composition									
Household wealth	0.011*	0.016***	0.014**	0.004	0.010**	0.007	0.007*	0.009**	0.008**
Liquidity	0.319**	0.187	0.268**	0.152	0.043	0.096	0.195**	0.137*	0.177**
Property rights									
Do they own titled land?	−0.157***	−0.161***	−0.174***	−0.110***	−0.103***	−0.125***	−0.079***	−0.078***	−0.085***
Human capital									
Age oldest spouse	−0.001	−0.002	−0.002	−0.002	−0.003*	−0.002	0.000	0.000	0.000
Spouses' education	0.004	0.005	0.004	0.009	0.010	0.009	−0.002	−0.002	−0.002
Additional male adults	0.057*	0.060**	0.055*	0.069***	0.068***	0.066***	0.011	0.011	0.010
Additional female adults	−0.047	−0.054*	−0.052	0.018	0.010	0.011	−0.063***	−0.074***	−0.064***
Intrahousehold dynamics									
Wife's share of household's wealth	0.067	0.021	0.044	−0.012	−0.010	−0.034	0.067	0.053	0.059
Is wife more educated than husband?	−0.096**	−0.062	−0.075*	−0.078**	−0.060*	−0.058*	−0.033	−0.014	−0.025
Did wife's parents have more land than husband's parents?	0.000	−0.001	0.000	−0.001	−0.001**	−0.001	0.000	0.000	0.000
Village dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Constant	0.419**	0.627***	0.446**	0.417***	0.880***	0.438***	0.475***	0.689***	0.484***
Log Likelihood	−99.767	−43.624	−98.264	−105.314	−2.161	−102.842	−41.113	36.686	−40.646
No. of observations: 210									

Note: single(*), double(**), and triple(***) asterisks represent the 10%, 5% and 1% levels of significance, respectively. # = Marginal effects evaluated at mean of regressors.

The higher efficiency levels achieved by wealthier households and by those with a larger share of liquid assets appear to be explained by the positive significant effect of wealth and liquidity on households' allocative efficiency—that is, on their ability to allocate their resources more efficiently.

The number of additional adults has significant explanatory power for economic efficiency. Households with more male labor exhibit higher technical efficiency, a sign that they were able to generate more output, either by working the land more intensively or by working off the farm. Interestingly, additional female labor is associated with lower allocative efficiency, suggesting that households with more adult women were unable to rely on the labor market to allocate their resources optimally, possibly reflecting the fact that the combination of activity-regulating social norms and reduced mobility because of their domestic responsibilities severely reduces the opportunities for women to participate in market-oriented activities.

Furthermore, the significant results associated with intrahousehold dynamics suggest that spouses may not always pool their resources.

A rather puzzling result is that households with titled land consistently underperform. While it has been argued that households without secure claims to land may choose to overinvest, using resources more intensively in order to strengthen their rights to it (Braselle, Gaspart, and Platteau 2002), tenure security does not seem to be a relevant consideration among the particular producers considered here. The average household in the sample has been occupying that same plot for twenty-two years, regardless of whether or not the household has a title for that land. Households with legal rights to their land are, however, wealthier—they operate more land, they own more animals—and they are older.

Lastly, and central to the question posed in this article, the results strongly suggest that households who are unable to meet their needs for capital are less efficient. Lacking sufficient access to working capital, households are limited in their ability to undertake income-maximizing projects, purchase inputs, or hire labor as needed. Estimates indicate that households who lack adequate access to credit are on average 25% less economically efficient than those who are able to meet their needs for capital.

These results remain largely unchanged when the sources of inefficiency are estimated using the *Spouses Model*—that is, when each spouse's individual access to credit is considered. Moreover, the effects of most variables are similar in sign, significance, and size, using either the two-step least square or the two-step tobit models.

However, in addition to the findings listed above, the results of the *Spouses Model* indicate a large and significant drop in households' efficiency when women are unable to meet their needs for capital. While the efficiency impact of their husbands' constraints in the capital market remains more or less the same, households in which women are credit constrained are approximately 11% more economically inefficient than those in which women's access to credit is adequate. More specifically, families in which women are credit constrained exhibit lower levels of technical efficiency, suggesting that credit-constrained women are unable to use the time they invest in income-generating activities more productively.

Overall, the results suggest that women's constraints in their access to credit have important implications for households' efficiency. Yet, it is important to emphasize that this source of inefficiency would have been entirely overlooked if, following the standard approach in the literature, the analysis was based only on information about the husbands' credit access.

Conclusions

An analysis of the economic performance of 210 rural households in Paraguay reveals significant room for improvement in efficiency levels: on average, family revenue is 30% lower than it could be. They are not using the best available technology—they could obtain more outputs with their given endowments—and they are not allocating their resources efficiently—they could increase the value of their production by choosing a different output combination.

A conventional examination of the data shows that credit constraints account for 25% of households' loss in efficiency. However, the credit-related loss of efficiency is significantly greater when women's position in the financial market is explicitly considered. In addition to the efficiency loss associated with the husbands' credit constraints, households experience an additional 11% drop in efficiency when the wives are unable to meet their need for capital.

These results have two important implications. First, they indicate that studies that try to measure the efficiency impact of credit constraints based only on the household head (if present, typically the husband) are likely to provide an incomplete assessment and significantly underestimate the true impact of those constraints.

In addition these results provide efficiency-based arguments for enhancing women's access to capital: policies and programs that improve women's access to credit would in turn lead to more efficient allocation of resources and increased production. Such policies must be designed to ease the market imperfections that particularly impact women, address the asymmetric allocation of resources, rights, and responsibilities within the household and promote the acknowledgment of women as productive contributors to the households' economy.

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