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ABSTRACT

Migration, Risk and the Intra-Household Allocation of Labor in El Salvador*

We use panel data from El Salvador and investigate the intra-household allocation of labor as a risk-coping strategy. Adverse agricultural productivity shocks both increased male migration to the US and male agricultural labor supply. This is not a contradiction if there were non-monotonic effects on shadow wages within the survey period. In contrast, damage sustained from the 2001 earthquakes *exclusively* stunted female migration. This is consistent with the earthquakes increasing the demand for home production.

JEL Classification: J22, J61

Keywords: migration, labor supply, insurance, intra-household allocation

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1 Introduction

The development literature has long documented that households in poor countries, where insurance markets are far from complete, often employ ingenious methods to cope with risk. Examples of these "non-market mechanisms" include transferring funds within villages or families (Townsend 1994; Udry 1994a; Yang and Choi 2006), depleting assets (Paxson 1992; Rosenzweig and Wolpin 1993; Udry 1994b), increasing labor supply (Kochar 1999), gaining additional household members (Frankenberg, Smith and Thomas 2003) and migrating (Rosenzweg and Stark 1989; Paulson 2000; Halliday 2006).[1] This paper addresses the role of the intra-household allocation of labor in buffering the effects of uninsured risk. Specifically, we concern ourselves with two questions. First, do exogenous shocks induce a reallocation of labor within the household? Second, if so, how does this reallocation affect the demographic composition of the household?

The reallocation of labor within the household in response to incentives that change across states of nature raises an interesting possibility, namely, that exogenous shocks may induce a redistribution of power within the family. In other words, although an adverse income or wealth shock may reduce the household's overall welfare in the utilitarian sense, it may also lead to an improvement in the positions of females *vis-a-vis* males inside the family due to the impact of the shock on relative shadow wages. What this suggests then is that interventions which are designed to improve the household's ability to manage risk may also need to bear these intra-household allocation issues in mind in order to bring about a Pareto improvement for all of the household members. It is this point which separates this study from much of the other literature on risk coping strategies in poor countries. However, we must emphasize that, while

[1] For a more thorough review of this literature, we refer the reader to Besley (1995).

effects on intra-household bargaining power are an interesting corollary of this research, these are not the focus of this paper. The focus of this paper is to investigate how risk affects the intra-household of labor. We leave any investigations into how these re-allocations of labor map into re-allocations of power for future research.

The balance of this paper is organized as follows. In the next section, we construct a simple partial equilibrium model of an agricultural household in which it reallocates labor across different sectors in response to changing incentives. After that, in the next four sections, we conduct an empirical analysis of the effects stochastic shocks on the intra-household allocation of labor. The last section concludes.

2 Some Theoretical Considerations

We outline a simple model that describes how the intra-household allocation of labor can be used to cope with exogenous shocks in the presence of skill differentials across genders. We assume that there are a total of S discrete states of nature which we index by s. Next, we assume that the household can reside in one of two locations: the north or the south. In addition, we assume that the there three goods: a consumption good which is produced in the south denoted by C_s, a consumption good that is produced in the north denoted by N_s and a good produced by a home production technology in the south denoted by H_s. The household behaves as a unitary actor and, thus, maximizes the expectation of a single utility function: $E[u(C_s, N_s, H_s)]$ which we assume to be increasing and concave in both of its arguments. It is important to emphasize that, although we are considering intra-household allocation issues in this paper, the simple unitary model that we consider here will serve as a perfectly adequate guide for us when we conduct our empirical analysis.

The household is endowed with a measure of female and male labor, each of which is normalized to unity. After observing the state of nature, the household allocates male and female labor either to the production of C, N or H. Male labor is denoted by the super-script M and female labor is denoted by the super-script F. Respectively, we let $\{m_s^M, l_s^M, h_s^M\}$ and $\{m_s^F, l_s^F, h_s^F\}$ denote the household's allocation of male and female labor to these three activities in state s. Finally, it is important to note that there are migration costs in this model as there is a cost and benefit to marginal utility of shifting household members across sectors. However, we do not model any other migration costs as this would further complicate the model by introducing dynamics.[2]

The household has the following production technologies. In the N-sector, it is given by $w_{j,s}m_s^j$ for $j = M$ or F where w_s^j denotes the northern wage. The production function in the C-sector is given by $\lambda(l_s^M, l_s^F, \psi_s)$ where ψ_s is a stochastic production shock. This technology models agricultural production in the south. Finally, the production function in the H-sector is given by $\eta(h_s^M, h_s^F, \varepsilon_s)$ where ε_s is a stochastic production shock. This technology models activities such as housework, child rearing and, perhaps, home maintenance. We assume that λ and η are increasing and concave in male and female labor.

Adopting the notation that u_X is the partial derivative of the utility function with respect to commodity X and that λ_M, λ_F, η_M and η_F are the partial derivatives of the production functions with respect to the male and female inputs, the optimal (interior) allocations of female and male

[2] While a dynamic model would certainly be more realistic, we do not believe that it would offer any additional insights.

labor are given by two conditions:

$$\frac{u_C(C_s, N_s, H_s)}{u_N(C_s, N_s, H_s)} = \frac{w_{j,s}}{\lambda_j(l_s^M, l_s^F, \psi_s)} \text{ for } j \in \{M, F\} \text{ and } s \in \{1, ..., S\} \tag{1}$$

and

$$\frac{u_H(C_s, N_s, H_s)}{u_N(C_s, N_s, H_s)} = \frac{w_{j,s}}{\eta_j(h_s^M, h_s^F, \varepsilon_s)} \text{ for } j \in \{M, F\} \text{ and } s \in \{1, ..., S\}. \tag{2}$$

These two conditions constitute a set of S contingency plans for all states of nature that the household will use to buffer the impact of risk. This will involve transferring labor from sectors with low demand and/or productivity to sectors with high demand and/or productivity. If we take these conditions together with the constraints that $l_s^j + m_s^j + h_s^j = 1$ for all s and j, we obtain the household's (reduced form) labor demand system $l_s^j = f^j(\varepsilon_s, \psi_s, w_{M,s}, w_{F,s})$, $m_s^j = g^j(\varepsilon_s, \psi_s, w_{M,s}, w_{F,s})$ and $h_s^j = m^j(\varepsilon_s, \psi_s, w_{M,s}, w_{F,s})$ for all s and j.

One interesting feature of this model is that it is capable of capturing some complicated labor supply responses to stochastic shocks. To see this, we implicitly differentiate (the inverse of) equation (1) with respect to l_s^j for $j \in \{M, F\}$ and ψ_s while holding the amount of labor allocated to the H-sector constant and assuming that $u_{NC} = 0$.[3] If we drop the arguments of the production and utility functions, this exercise obtains

$$\frac{\partial l_s^j}{\partial \psi_s} = \Delta^{-1} \left[\underbrace{\frac{u_N * u_{CC} * \lambda_\psi}{u_C^2}}_{\text{Consumption Effect}} + \underbrace{\frac{\lambda_{j\psi}}{w_j}}_{\text{Productivity Effect}} \right] \text{ for } j \in \{M, F\} \text{ and } s \in \{1, ..., S\} \tag{3}$$

[3] Otherwise, the comparative static becomes too complicated. Allowing for these additional complications does not add any more insights.

where $\Delta \equiv -\frac{u_N * u_{CC} * \lambda_j}{u_C^2} - \frac{\lambda_{jj}}{w_j}$.[4] Note that our assumptions imply that $\Delta > 0$. The first term in brackets, which we call the "Consumption Effect," will be negative provided that $\lambda_\psi > 0$. The intuition of this is that if the household experiences a positive shock to the production of C in some state of nature then its labor demand in that sector will decrease. The second term, which we call the "Productivity Effect," will be positive provided that $\lambda_{j\psi} > 0$. This effect tells us that if a shock increases the marginal product of labor in the C-sector in a given state of nature then the household will tend to allocate additional labor to that sector. It is important to realize that it is reasonable to expect both $\lambda_\psi > 0$ and $\lambda_{j\psi} > 0$ so that a beneficial (adverse) productivity shock will positively (negatively) impact both the level of production and the marginal returns to labor. If and when this occurs, then there will be counter-veiling forces affecting the net impact of the shock.

Another important feature of this model which warrants some discussion is corner solutions. These are important in our model because they will have implications for how the effects of stochastic shocks differ across genders. To better see this, consider a household that is at an interior allocation for females in the N and H sectors, but is at a corner for males in the sense that it has allocated positive labor to the N sector but no labor to the H sector. In this scenario will have that

$$\frac{u_H(C_s, N_s, H_s)}{u_N(C_s, N_s, H_s)} = \frac{w_{F,s}}{\eta_F(h_s^M, h_s^F, \varepsilon_s)} < \frac{w_{M,s}}{\eta_M(h_s^M, h_s^F, \varepsilon_s)}. \tag{4}$$

[4] An equivalent statement is that

$$\frac{\partial l_s^j}{\partial \psi_s} = \Lambda^{-1}\left[\frac{u_{CC} * \lambda_\psi}{u_N} + \frac{w_j}{\lambda_j^2}\lambda_{j\psi}\right]$$

where $\Lambda \equiv -\frac{u_{CC} * \lambda_j}{u_N} - \frac{w_j}{\lambda_j^2}\lambda_{jj}$. One can derive equation (3) from this equation by multiplying its numerator and denominator by $\left(\frac{\lambda_j}{w_j}\right)^2$ and then substituting for λ_j^2 using the first order condition in equation (1).

Now suppose that the household gets hit by a shock that reduces the level of its production of H but leaves marginal productivity in this sector unchanged. This will tend to increase the marginal utility of H and, hence, the first term of condition (4). To restore equilibrium, the household can increase the amount of female labor allocated to the H-sector. However, unless the shock is sufficiently bad that it reverses the inequality on the right side of the condition, it will leave male labor in that sector unchanged at zero. This suggests that shocks should have smaller effects on the labor supply of a particular gender when households are more likely to be at corners for that gender.

3 Data

3.1 BASIS

Our primary data source is the BASIS Panel from El Salvador which was fielded by the Ohio State University and the Fundación Salvadoreño para Desarollo Económico y Social (FUSADES).[5] We employ three waves of the panel from 1997, 1999 and 2001. The data contain identifiers which enable us to track households across time.

Table 1 contains descriptive statistics and definitions for our variables on migration, hours worked in various household activities, land holdings and economic shocks.[6] Because the agricultural shocks are only available for 1999 and 2001, most of our regressions only use these

[5]For a more thorough discussion of these data including an analysis of panel attrition, we refer the reader to Halliday (2006).

[6]Two points need mentioning. First, we define a migrant to be a household member that is residing in either the United States or Canada at the time of the survey where a household member is defined to be someone who is tied to the household by blood or marriage. Second, while it is impossible to know whether a migrant was residing in the United States or Canada, we believe that it is reasonable to assume that the vast majority of migrants are residing in the United States. Because of this, for the remainder of the paper, we refer to all migrants as residing in the United States.

years. However, the 1997 data was still used in these regressions to construct lags of some of our variables.

Some additional details need to be given on the data on hours worked. These data come from a component of the BASIS survey that listed numerous household activities and then asked, “Cuánto tiempo trabajó en esa actividad?” or “How much time did he (she) work in that activity?” We employ data for three activities. The first is what we call field labor. In the survey, this is defined as “Trabajo agrícola para venta o autoconsumo” or “Agricultural work for sale or auto-consumption.” We call the second, livestock labor, which the survey defines as “Cuidado de animales para venta o autoconsumo” or “Care of animals for sale or auto-consumption.”[7] Finally, we call the third, domestic labor, which the survey defines as “Labores domésticas (preparación de alimentos, limpieza, cuido de niños y enfermos)” which, in English, is “Domestic labor (preparation of food, cleaning, care of children and the sick).”

Our stochastic shocks come from two sources: poor agricultural conditions in 1999 and 2001 and the earthquakes of 2001. The agricultural shocks are dummy variables indicating income loss from either harvest or livestock loss.[8] Our earthquake shock is an index corresponding to the (log of) monetary value of damage sustained from the 2001 earthquakes.

As in Udry (1994a and 1994b), all of our shocks are based on self-reports. Some recent

[7] It is important to note that the BASIS survey does not explicitly say that what we define as “field labor” constitutes work such as planting, tending to and/or harvesting crops. However, the survey does list caring for livestock as a separate activity from what they call agricultural activity. Accordingly, we infer that agricultural labor as defined by the survey does not include hours spent tending to livestock and, thus, includes primarily activities which involve crops.

[8] Due to changes in survey design in the years 1999 and 2001, the construction of the harvest and livestock loss dummies warrants some discussion. In 1999, the household was defined to have experienced a harvest loss if they reported that they lost all or part of their harvest and that this event caused them to lose income. In 2001, the household was defined to have experienced a harvest loss if they reported that the value of their harvest was less than normal *as a consequence of a drought which occurred in 2001.* Unfortunately, the 1999 survey did not solicit the actual cause of the harvest loss and, hence, it is not possible to have comparable measures of harvest losses in 1999 and 2001. To address this issue, in Halliday (2006), we estimated our models separately for 1999 and 2001 to ensure that the results were comparable in the two years. They were.

papers have shied away from self-reported shocks and, instead, have relied on variables that are supposedly more exogenous like rainfall. However, rainfall data do have many disadvantages. For example, in a country as small as El Salvador, there may not be sufficient regional variation. More importantly, rainfall data is collected at some regional level such as a department or a *municipio* and this precludes the use of many location dummies which raises many omitted variables concerns. In contrast, our shocks do vary within geographic units.[9] Finally, we provide evidence in this paper and in Halliday (2006) which mitigates many of the endogeneity concerns that have been raised with the self-reported shocks.

Table 2 provides information on the demographic composition of households in the BASIS data. This demographic information excludes all migrants. The categories in this table were used to construct demographic controls in our regressions.

3.2 IPUMS

We also employ data on a sub-sample of Salvadoran migrants from the 5% micro-sample of the 2000 United States Census (Ruggles, *et al.* 2004). We define a Salvadoran migrant as one who resides in El Salvador five years prior to being interviewed. There are 5251 such individuals in the 2000 Census. Because we are interested in using these data to quantify wage differentials by gender, we further restrict the sample to working-aged people which we define to be 20 years or older. This further reduces the sample to 3738. We employ variables on wages, age, years in the United States, employment status, citizenship status and education. Wages were constructed by dividing the respondent's total wage income in the year by the number of hours per week that

[9] For example, Halliday (2006) provides nonparametric density estimates of earthquake damage within departments and shows that there is considerable intra-regional variation.

the respondent reported to work multiplied by 52. Summary statistics are reported in Table 3.

4 Risk and the Gender Composition of Migrant Flows

We begin our empirical analysis by investigating how exogenous shocks in El Salvador impact the gender composition of migrant flows. Our benchmark regression equation is similar to that in Halliday (2006) and, with some abuse of notation, is given by

$$\Delta M_{h,t}^{j} = \alpha^{j} + \zeta_{t}^{j} + \omega_{h,t}'\delta^{j} + R_{h}'\rho^{j} + X_{h,t-1}'\beta + \varepsilon_{h,t}^{j} \text{ for } j \in \{M, F\} \tag{5}$$

where $\Delta M_{h,t}^{j}$ is the change in the stock of male or female migrants across time periods, ζ_{t}^{j} is a year effect, $\omega_{h,t}$ is a vector of exogenous shocks such as the harvest and livestock loss dummies and the earthquake damage index, R_h is a set of location dummies and $X_{h,t}$ is a set of demographic controls which were discussed in Table 2. Two sets of location dummies are employed: department dummies of which there are 14 and municipio dummies of which there are 173.[10] To address the obvious endogenity concern that migration will have a contemporaneous impact on the household's demographic structure, we use lags of $X_{h,t}$. We estimate the model using an ordered logit estimator with the 2001 and 1999 waves of the BASIS panel. The advantage of the ordered logit model is that it uses ancillary parameters which enable us to handle the dependent variable in a flexible manner. To account for the possibility of correlations across observations within *municipios*, we cluster all standard errors by *municipio*. Table 4 reports our

[10] In fact, there are 262 *municipios* in El Salvador, but only 173 of these are present in our data due to the small sample sizes in the BASIS data. In addition, for some of the regressions in this paper, some *municipio* dummies were dropped due to collinearity with the agricultural shock dummies.

results for male migration and Table 5 reports our results for female migration.

The first column of Table 4 displays estimation results when the dependent variable is total migration (*i.e.* the sum of male and female migration) as a reference. We see that the agricultural shocks had a positive and significant impact on migration, whereas the earthquakes had a negative and significant impact on migration. The explanation that we give in Halliday (2006) for this result is that adverse agricultural conditions in El Salvador expanded the north-south wage gap and, thereby, increased the incentives for northward migration, whereas the earthquakes increased the demand for labor at home which was met by a reduction in migration. In that paper, we explored the possibility that the earthquakes stunted migration because they disrupted migration financing, but the preponderance of evidence that we uncovered did not support this alternative hypothesis.

In the second column of the table, we provide a simple identification check. First, we take the shocks from the 2001 (1999) wave of the panel and merge them into the 1999 (2001) wave. We call these "counterfactual" shocks. We then estimate the specification from the first column using these counterfactual shocks while omitting the actual shocks. The central idea of this exercise is that if households have time-invariant characteristics that are systematically correlated with both migration and the shocks then these counterfactual shocks should pick up false treatments.[11] What we see is that the F-tests at the bottom of the column cannot reject the null that the counterfactual shocks all have zero coefficients which mitigates some of these omitted variables concerns.

Columns three through six of Table 4 use male migration as the dependent variable. In

[11] These omitted variable biases may arise if the shocks were non-randomly assigned to households that either had weak ties to the United States or were poorer. In both scenarios, the shocks would have been assigned to households that had unobserved characteristics that made them less likely to migrate.

all four columns, we see that adverse agricultural shocks had a positive and significant impact on migration. All tests of joint significance had p-values less than 10%. In addition, it is important to point out that in column six we use *municipio* dummies and, while the agricultural shock dummies are no longer individually significant, they are still jointly significant at the 10% level.[12] We must emphasize that, while the standard errors on the agricultural shocks are substantially higher, the point estimates are broadly in-line with the others in the table. This substantially mitigates concerns of omitted variables bias.[13] Interestingly and in stark contrast to the first column, we see that there is no relationship between the earthquakes and male migration.

Turning to the results for female migration in Table 5, we see a substantially different picture. Now the relationship between the agricultural shocks and migration is more muted than in the previous table as can seen by the lower point estimates and F-tests in the bottom of the table. In addition, we now see a large, negative and statistically significant relationship between the earthquakes and migration. In fact, the point estimates in this table are substantially larger than the estimate in the first column of the previous table where the dependent variable was total migration. Finally, the earthquake effects are greatest when we include the *municipio* dummies which, once again, mitigates many omitted variables concerns.

We conclude this section by addressing the additional identification consideration that the

[12] While this procedure does mitigate omitted variables concerns, it also eliminates a substantial amount of variation in the shocks - much of which is meaningful variation. As such it is unreasonable to expect high t-statistics on the agricultural shocks as this is a highly inefficient procedure. Because of this, the fact that we have such a low p-value on our F-tests is a strong testament to our claim that our agricultural shocks are probably not picking up omitted variables.

[13] For example, the areas in El Salvador with long histories of migration to the US are in the rural northern and eastern parts of the country which were hit hardest by the civil war. It might be reasonable to expect that these areas also have a higher prevalence of risky agricultural activities which could create a spurious relationship between the agricultural shocks and migration. For a more comprehensive discussion of some of these omitted variables concerns, see Halliday (2006).

terrorist attacks of September 11 may have had an impact on our conclusions. We do not believe that they have. The primary reason is that the year dummy in the regression equation should adequately control for any macroeconomic shocks that occurred in 2001. Even if there were some heterogeneity in the effects of the terrorist attacks that is not fully dealt with by the year dummy, it would have to be systematically correlated with our shocks to bias our results. We do not see why this should be the case.

5 Gender Differences in Wages and Employment

In this section, we investigate gender differences in wages and employment both in El Salvador and among Salvadoran migrants in the United States.[14] Our goal is to gain a better understanding of how labor is allocated across sectors in Salvadoran households with the ultimate aim of better understanding how the effects of stochastic shocks should differ by gender. We do so using a sample of Salvadorans from the US Census and as well as the BASIS data.

5.1 In the United States

We now investigate male-female differentials in wages and employment status among Salvadoran migrants in the US. Looking at Table 3, two facts emerge. First is that the average US wage

[14] There is a large literature on gender differences in wages and employment in both developing and developed countries. For an excellent overview of this literature, we refer the reader to Mammen and Paxson (2000). Some of this literature has focused on determining whether these observed differentials are the consequence of productivity/skill differences across genders or discrimination. Unfortunately, understanding the role that productivity differences play in determining wage and employment disparities across genders has, to a large degree, been hampered by a dearth of data on individual productivity. One notable exception, however, is Foster and Rosenzweig (1996) who do have piece-rate data and conclude that women tend to be engaged in different activities than men because of differences in comparative advantage across genders and statistical discrimination. That they find an important role for productivity differences (albeit in a different context) does lend credence to our model which assumes that labor allocation differences across genders are due to comparative advantage.

of Salvadoran women, including women who are not in the labor force, is $2.16 less than a Salvadoran male. Second is that a far greater number of Salvadoran women (46.39%) report being out of the labor force than Salvadoran men (25.02%) suggesting that this wage gap is driven largely by differences in labor force participation.[15] To give the reader a more comprehensive picture of these wage gaps, we plot the cumulative density functions (CDF) of wages for men and women in Figure 1. It can be seen that the male CDF dominates the female CDF and that the largest discrepancies exist when wages are zero.

We can combine this with migration information from Table 1 to get a sense of how many members in each household are both living abroad and in the labor force. According to Table 1, the average number of female and male migrants per household is 0.19 and 0.36, respectively. Using the labor force participation rates from the US census, we obtain that there are a total of $0.19 * 0.5361 = 0.1019$ females per household that are working migrants. The corresponding number for males is $0.36 * 0.7498 = 0.2699$. These calculations suggest that there are roughly 2.6 times as many working male migrants than female migrants per household.

In Table 6, we estimate wage regressions. The explanatory variables are gender, age, experience in the US, education and citizenship status. In the first four columns, we used OLS. In the fifth and sixth columns, we estimated a Tobit model and the censored least absolute deviations (CLAD) regression of Powell (1984).[16] It can be seen that even after we adjust for

[15] These discrepancies most likely reflect different migration motives among men, who generally migrate for economic reasons, and women, who generally migrate to be reunited with their families. See Donato (1994) for a discussion of these motives in the case of Mexican migration.

[16] We prefer the OLS results and the CLAD results to the Tobit results. One reason why we like the OLS results is that we are interested in knowing the impact of gender on average wages which includes both the extensive margin (*i.e.* labor force participation) and the intensive margin (*i.e.* wage differentials among earners). In fact, the fact that the censoring is substantially higher for women is indicative that the wages that Salvadoran women would have earned had they entered the labor force was lower than their reservation wages. A simple OLS regression conveniently summarizes this. In addition, Tobit models typically rely heavily on homoskedastic disturbances and when this fails their performance can be weak. Both OLS and CLAD are robust to failures of

a number of potentially confounding variables, men still earn more than two dollars per hour more than women in the OLS regressions. In the last two columns, which display the results of censored regressions, the gap is $4.65 in column 5 and $3.33 in column 6.[17] The fact that female wages in the US are so low makes sense of the fact that so many households in our data choose corner solutions for their allocation of female labor abroad. In addition, when one considers the discussion of condition (4) in the theoretical section, the high prevalence of these corner solutions also makes sense of the observation in the previous section that the agricultural shocks had substantially larger impacts on men.[18]

5.2 In El Salvador

We now turn to an investigation into how the distribution of hours worked in various household activities differs across genders in El Salvador.[19] The activities that we consider are field, livestock and domestic labor and were discussed in Section 3.1. We calculate CDF's for the total number of hours devoted to each of these activities by an individual during the survey year by gender. For the sake of clarity, it is important to emphasize that in contrast to the bulk of this paper where we work with household aggregates, these figures display hours worked per year at the level of the individual. The results of this exercise are displayed in Figures 2, 3 and 4 for field, livestock and domestic labor, respectively. These results indicate, perhaps not surprisingly,

homoskedasticity. For additional opinions on this, we refer the reader to Deaton (1997).

[17] We bootstrapped the standard errors in column 6 when CLAD was employed using 100 replications.

[18] While these results do suggest that economic considerations play an important role in the household's allocation problem, it is also important to mention that prevailing social mores in Central America about the vulnerability of women may also mean that the costs of migration, as perceived by the household, may be substantially higher for women (Curran and Rivero-Fuentes 2003).

[19] In the Salvadoran data, we focus on hours worker as opposed to wages due to the fact that in developing countries a large proportion of labor is not in the wage sector.

that field labor is by-and-large (but not entirely) men's work and that domestic labor is almost exclusively women's work. They also indicate that men are marginally more likely than women to be engaged in livestock labor.

These figures elucidate the previous section's results in two ways. First, given that most households were at a corner solution in which no women were engaged in either field activities in El Salvador or wage labor in the US, we would expect the agricultural shocks to have smaller effects on female migration as we have seen. Second, given that Figure 4 suggests that the home is the woman's domain, it is not surprising that the earthquakes, which ostensibly increased the demand for home production, were met exclusively by a reduction in female migration.

6 Risk and the Intra-Household Allocation of Labor

We now investigate how stochastic shocks induced a re-allocation of labor within the household in El Salvador. We define $H_{h,t}^{j,s}$ to be the number of labor hours devoted to sector s by all members of household h of gender j in year t where the sectors are field, livestock and domestic activity. We also define $h_{h,t}^{j,s}$ completely analogously to $H_{h,t}^{j,s}$ except that $h_{h,t}^{j,s}$ is the number of hours devoted to a particular labor activity per adult male or female (*i.e.* total hours worked by the household divided by the number of adult men or women).[20] We then estimate a similar model to equation (5) except that we use $\Delta H_{h,t}^{j,s}$ and $\Delta h_{h,t}^{j,s}$as the dependent variables. Tables 7 and 8 report the OLS estimates when the dependent variables are $\Delta H_{h,t}^{j,s}$ and $\Delta h_{h,t}^{j,s}$, respectively. Each regression includes a set of department dummies and (lagged) demographic controls. A perusal of the tables reveals several interesting results.

[20] We define an adult to be anyone 16 years of age or older.

First, we consider the coefficient estimates on the earthquake damage index. In the last column of both tables, we see that households that were hit hard by the earthquakes also experienced a dramatic increase in the number of hours devoted to domestic labor by women. The proper interpretation of the point estimate in Table 7 is that a 1% increase in earthquake damage is associated with an increase in *total* hours devoted to domestic labor by women of 1.54. This implies that a household that was hit three times harder by the earthquakes than another experienced a 462 hour increase in hours devoted to domestic work by women during the year, on average! In contrast, in column five of both tables, we see that the earthquakes had no effect on male hours devoted to domestic activities. Finally, we note that the estimate on earthquake damage in column four of both tables, where the dependent variable is the change in livestock hours worked by women, is negative and moderately significant suggesting that the earthquakes may have induced a substitution away from livestock production towards home production.

Next, we consider the effects of the two agricultural shocks on hours. In both tables, we see that harvest losses had large, positive and significant effects on field hours for men. We also see that livestock losses had similar effects on livestock hours for both men and women, although in Table 8, the effects on male hours are no longer significant. However, livestock losses had no effects on field hours, nor did harvest losses have any effects on livestock hours for either men or women.

These results may seem counter-intuitive at first. The reason for this is that the harvest and livestock shocks presumably lowered marginal productivity in agricultural activities in El Salvador which would also tend to reduce (shadow) wages. One would expect that such a productivity shock would, in turn, induce a substitution away from (not towards) agricultural activities. However, it is important to mention that a similar result can be found in Frankenberg, Smith and Thomas (2003) who show that there was a tendency for labor supply to increase in the aftermath of the Indonesian financial crisis despite the fact that it caused a 40% reduction in real wages in the formal sector.

Do these findings pose a paradox? The comparative static in equation (3) shows that adverse agricultural shocks can increase labor demand in the agricultural sector - provided that the consumption effect dominates any adverse effects on the marginal product of labor. However, in this scenario, the shadow wage in agriculture should increase due to higher labor demand which is seemingly inconsistent with the observation that household members migrated in response to adverse agricultural shocks.

One can resolve this paradox if one considers the possibility that the effects of the shocks on shadow wages differed within the survey period. First, suppose that the shock initially reduced the marginal product of labor in such a way that the productivity effect dominated the consumption effect in equation (3). This would reduce labor demand and shadow wages. In response, members migrate out of the household. This then places upward pressure on shadow wages and, thus, induces the household to allocate more labor to agriculture. Second, backwards bending labor supply curves may also shed light on this puzzle. Suppose that the net effect of the shocks were such that the consumption effects dominated the productivity effects so that labor demand in agriculture increased in response to the shock. In the presence of backwards bending labor supply curves, this would actually reduce the shadow wage and, thus, create additional pressures to migrate.[21] As members migrate in response to this wage decrease, the shadow wage

[21] Many readers may express surprise that labor supply curves would bend backwards in a poor country such as El Salvador. However, subsistence considerations can actually create this phenomenon. To see this, consider a simple model in which the household earns $Y = wL$ but needs to maintain Y above $\underline{Y}$ to survive. In this

would then start to increase.

7 Conclusions

We investigated how the intra-household allocation of labor responds to stochastic shocks within the context of an equilibrium model of a farm household using panel data from El Salvador. We showed that adverse shocks in the agricultural sector were met by increases in the number of male migrants living in the US and increases in male hours devoted to agricultural activities. The first finding is consistent with data on labor supply from the US and El Salvador which showed that most households did not allocate any women either to wage labor abroad or to agricultural activities at home. We argued that both of these findings are compatible with each other if one allows for the possibilities that shocks had non-monotonic effects on shadow wages within the survey period. In contrast, damage sustained by households due to the 2001 earthquakes had a large negative effect on female migration, but had absolutely no effect on male migration. We also showed that the earthquakes were met by a dramatic increase in the number of hours that women devoted to domestic labor, but had no impact on male domestic hours. This is consistent with the finding in our data that over 90% of all households do not allocate any males to domestic activities. Thus, it appears that it was the women who picked up the pieces left by the disaster.

One implication of this work is that exogenous shocks induce re-allocations within the household in ways that may alter bargaining power of individuals. Within a collective model of

world, a sufficiently large decrease in wages actually induces more labor supply. We thank Raymond Robertson for pointing this out to us.

household decision making *a la* Chiappori (1992) or Browning, Bourguignon, Chiappori and Lechene (1994), this would potentially change the way that resources are allocated within the household. A study into this issue would be interesting as it would elucidate an additional channel through which migration and other risking-coping strategies can impact household welfare. This is a challenging topic. First, it requires adequate data so that consumption can be assigned to individuals. Second, identification is apt to be very difficult. For example, although we have good reasons to believe that the exogenous shocks that we consider in this paper affected intra-household bargaining power, they also had large effects on the household's total budget constraint which would also affect resource allocation. Disentangling these two effects from each other should be challenging.

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Table 1: Basis Data - Summary Statistics

	Definition	Mean (Standard Deviation)
Migrants[1]	Number of household members residing in the United States	0.55 (1.23)
- Women		0.19 (0.62)
- Men		0.36 (0.83)
Field Hours[1]	Total number of hours in the year that household members devoted to field labor	1065.33 (1584.32)
- Women		70.21 (341.17)
- Men		995.12 (1512.21)
Livestock Hours[1]	Total number of hours in the year that household members devoted to caring for livestock	474.17 (928.88)
- Women		234.33 (489.25)
- Men		239.84 (723.92)
Domestic Hours[1]	Total number of hours in the year that household members devoted to domestic labor	4533.91 (3439.47)
- Women		4311.83 (3108.16)
- Men		222.09 (1024.85)
Land Holdings[1]	Total land holdings (in manzanas) of the household that either has a title or documents indicating the power of transfer	1.69 (5.38)
Harvest Loss[2]	Dummy indicating income loss due to harvest loss	0.19 (0.39)
Livestock Loss[2]	Dummy indicating income loss due to livestock loss	0.11 (0.31)
Quakedamage[3]	Cost of all household damage due to the 2001 earthquakes (in 1992 $, in logs)	4.64 (3.80)

[1]Data is from 1997, 1999 and 2001. Sample size is 2008.
[2]Data is from 1999 and 2001. Sample size is 1365.
[3]Data is from 2001. Sample size is 689.

Table 2: Basis Data - Demographic Variables

Age Bracket	Men	Women
< 1	0.04	0.04
	(0.21)	(0.19)
1 - 15	1.18	1.20
	(1.29)	(1.26)
16 - 20	0.38	0.37
	(0.65)	(0.63)
21 - 45	0.75	0.89
	(0.76)	(0.71)
> 45	0.62	0.53
	(0.55)	(0.55)

*Standard deviations are reported in parentheses. Data are from the 1997, 1999 and 2001 waves of the survey.

Table 3: IPUMS Data on Salvadoran Migrants in the US

	Men	Women
Wage	5.44	3.28
	(6.45)	(8.79)
Age	30.70	34.26
	(12.29)	(15.02)
Years in the US	3.99	4.21
	(5.65)	(6.29)
Employment distribution		
- Employed	69.39%	45.66%
- Unemployed	5.58%	7.95%
- Not in labor force	25.02%	46.39%
Citizenship Status		
- Born abroad of American Citizens	0.20%	0.44%
- Naturalized Citizen	4.98%	5.00%
- Not a citizen	94.82%	94.56%
Education		
- None	13.76%	14.46%
- 1 to 4 Years	8.04%	7.95%
- 5 to 8 Years	25.70%	24.04%
- 9 Years	11.36%	9.58%
- 10 Years	2.89%	2.83%
- 11 Years	3.08%	3.19%
- 12 Years	22.95%	22.47%
- 1 to 3 Years of College	7.75%	10.06%
- 4 or more Years of College	4.48%	5.42%

*The data in this table come from a sub-sample of Salvadorans in the US who were residing in El Salvador in 1995 who were at least 20 years old. Standard deviation in parentheses.

Table 4: Migratory Responses to Adverse Shocks: Male Migration

	(1)[3]	(2)[3,4]	(3)	(4)	(5)	(6)
Harvest Loss	0.31	−0.23	0.40	0.40	0.36	0.34
	(1.89)	(−1.33)	(2.23)	(2.18)	(1.97)	(1.49)
Livestock Loss	0.36	−0.00	0.29	0.28	0.31	0.40
	(1.84)	(−0.02)	(1.17)	(1.13)	(1.23)	(1.50)
Earthquake Damage	−0.05	0.00	−0.01	−0.01	−0.00	0.00
	(−2.15)	(0.02)	(−0.60)	(−0.61)	(−0.09)	(0.16)
2001 Dummy	−0.28	−0.40	−0.40	−0.38	−0.43	−0.49
	(−1.55)	(−2.05)	(−2.22)	(−2.09)	(−2.27)	(−2.32)
Demographic Variables[1]	No	No	No	Yes	Yes	Yes
Municipio Dummies	No	No	No	No	No	Yes
Department Dummies	No	No	No	No	Yes	No
Decomposition?	All	All	Male	Male	Male	Male
F-test on Agricultural Shocks[2]	8.32	1.78	7.59	7.29	7.09	5.60
	[0.016]	[0.411]	[0.023]	[0.026]	[0.029]	[0.061]
F-test on All Shocks[2]	12.18	1.79	7.83	7.54	7.09	5.73
	[0.007]	[0.616]	[0.050]	[0.057]	[0.069]	[0.126]
Pseudo R^2	0.0078	0.0039	0.0070	0.0080	0.0237	0.0601
Households	1265	1244	1265	1265	1265	1265

*This table contains estimates from an ordered logit model where the dependent variable is male migration.

**All standard errors allow for clustering within municipios.

***t-statistics reported in parentheses.

[1]The demographic controls that were used are indicators for the number of household members at home within certain age and gender brackets reported in Table 2.

[2]p-values are reported below each F-statistic.

[3]In this column, the dependent variable is the sum of male and female migration.

[4]In this column, we employed the "counterfactual" shocks described in Section 4.

Table 5: Migratory Responses to Adverse Shocks: Female Migration

	(1)	(2)	(3)	(4)
Harvest Loss	0.29	0.29	0.26	0.22
	(1.64)	(1.63)	(1.43)	(0.99)
Livestock Loss	0.20	0.20	0.19	0.27
	(0.92)	(0.93)	(0.83)	(1.03)
Earthquake Damage	−0.07	−0.07	−0.07	−0.09
	(−2.17)	(−2.13)	(−2.02)	(−2.17)
2001 Dummy	−0.09	−0.11	−0.11	−0.02
	(−0.36)	(−0.41)	(−0.40)	(−0.08)
Demographic Variables[1]	No	Yes	Yes	Yes
Municipio Dummies	No	No	No	Yes
Department Dummies	No	No	Yes	No
F-test on Agricultural Shocks[2]	3.87	3.94	2.94	1.88
	[0.145]	[0.140]	[0.230]	[0.390]
F-test on All Shocks[2]	9.12	8.91	7.26	7.14
	[0.028]	[0.030]	[0.064]	[0.068]
Pseudo R^2	0.0082	0.0130	0.0170	0.0769
Households	1265	1265	1265	1265

*This table contains estimates from an ordered logit model where the dependent variable is female migration.

**All standard errors allow for clustering within municipios.

***t-statistics reported in parentheses.

[1]The demographic controls that were used are indicators for the number of household members at home within certain age and gender brackets. Details are in Section 2.3.

[2]p-values are reported below each F-statistic.

Table 6: US Wage Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Sex Dummy (= 1 if male)	2.09	2.07	2.11	2.09	4.65	3.33
	(8.40)	(8.35)	(8.54)	(8.45)	(12.19)	(9.00)
Age	0.28	0.22	0.20	0.20	0.55	0.35
	(6.16)	(4.83)	(4.21)	(4.21)	(6.70)	(3.5)
Age^2	-0.003	-0.003	-0.003	-0.003	-0.008	-0.005
	(-6.82)	(-5.69)	(-4.99)	(-5.06)	(-8.22)	(3.33)
US Experience	-	0.30	0.31	0.33	0.52	0.82
		(7.22)	(7.40)	(7.60)	(7.42)	(4.82)
US Experience^2	-	-0.005	-0.006	-0.006	-0.010	-0.036
		(-4.94)	(-5.26)	(-5.67)	(-4.65)	(-3.00)
Education Dummies?	No	No	Yes	Yes	Yes	Yes
Citizenship Status Dummies?	No	No	No	Yes	Yes	Yes
Estimation Method	OLS	OLS	OLS	OLS	Tobit	CLAD
R^2	0.0327	0.0469	0.0548	0.0571	0.0216	0.0637
N	3738	3738	3738	3738	3738	3738

*These regressions use the same data as Table 3. t-ratios are in parentheses.

Table 7: Adverse Shocks and Hours Worked

	Δ Field Hours		Δ Livestock Hours		Δ Domestic Hours	
	Men	Women	Men	Women	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Harvest Loss	336.53	53.66	29.30	−44.63	−94.78	−71.01
	(2.69)	(1.22)	(0.40)	(−0.86)	(−1.04)	(−0.25)
Livestock Loss	63.16	28.55	155.36	134.41	−59.90	612.01
	(0.41)	(0.47)	(1.96)	(2.36)	(−0.66)	(1.90)
Earthquake Damage	13.40	3.27	9.37	−11.73	8.38	153.80
	(0.90)	(0.62)	(1.11)	(−1.82)	(0.33)	(3.86)
2001 Dummy	−8.07	−5.43	−283.07	−98.54	−435.66	−179.53
	(−0.07)	(−0.16)	(−4.39)	(−2.38)	(−1.67)	(−0.48)
R^2	0.0384	0.0207	0.0381	0.0405	0.0203	0.0644
Households	1265	1265	1265	1265	1265	1265

*This table contains OLS estimates where the dependent variable is the change in hours worked in a particular sector broken down by gender. All regressions contain lagged demographic controls and department dummies.
**All standard errors allow for clustering within municipios.
***t-statistics reported in parentheses.

Table 8: Adverse Shocks and Hours Worked

	Δ Field Hours		Δ Livestock Hours		Δ Domestic Hours	
	Men	Women	Men	Women	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Harvest Loss	134.43	39.99	53.23	−47.50	−52.40	106.98
	(2.07)	(1.58)	(1.19)	(−1.15)	(−0.78)	(0.64)
Livestock Loss	61.60	10.09	69.10	80.74	−19.80	312.64
	(0.76)	(0.37)	(1.32)	(1.98)	(−0.35)	(1.64)
Earthquake Damage	1.31	1.15	5.57	−10.15	−2.88	49.42
	(0.19)	(0.41)	(1.07)	(−2.17)	(−0.25)	(2.20)
2001 Dummy	12.24	−0.37	−180.24	−65.37	−218.45	81.87
	(0.23)	(−0.02)	(−4.09)	(−2.13)	(−2.12)	(0.38)
R^2	0.0247	0.0129	0.0403	0.0370	0.0292	0.0429
Households	1265	1265	1265	1265	1265	1265

*This table contains OLS estimates where the dependent variable is the change in hours worked per adult male or female in a particular sector broken down by gender. All regressions contain lagged demographic controls and department dummies.

**All standard errors allow for clustering within municipios.

***t-statistics reported in parentheses.

Figure 1

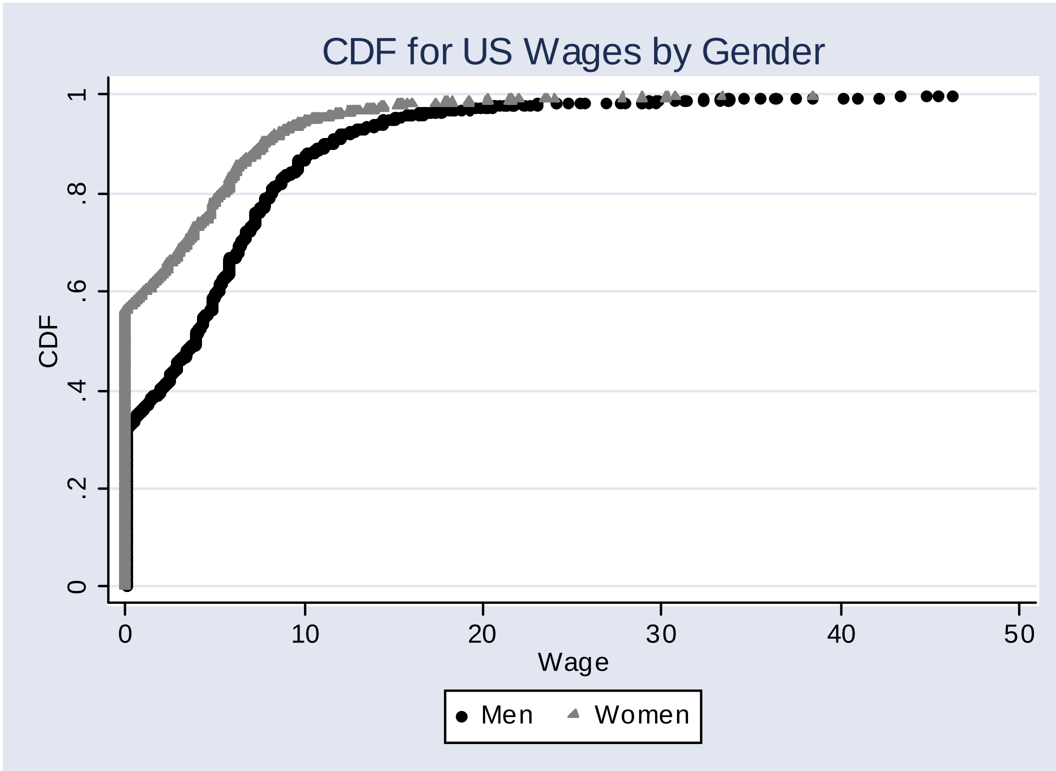

Figure 2

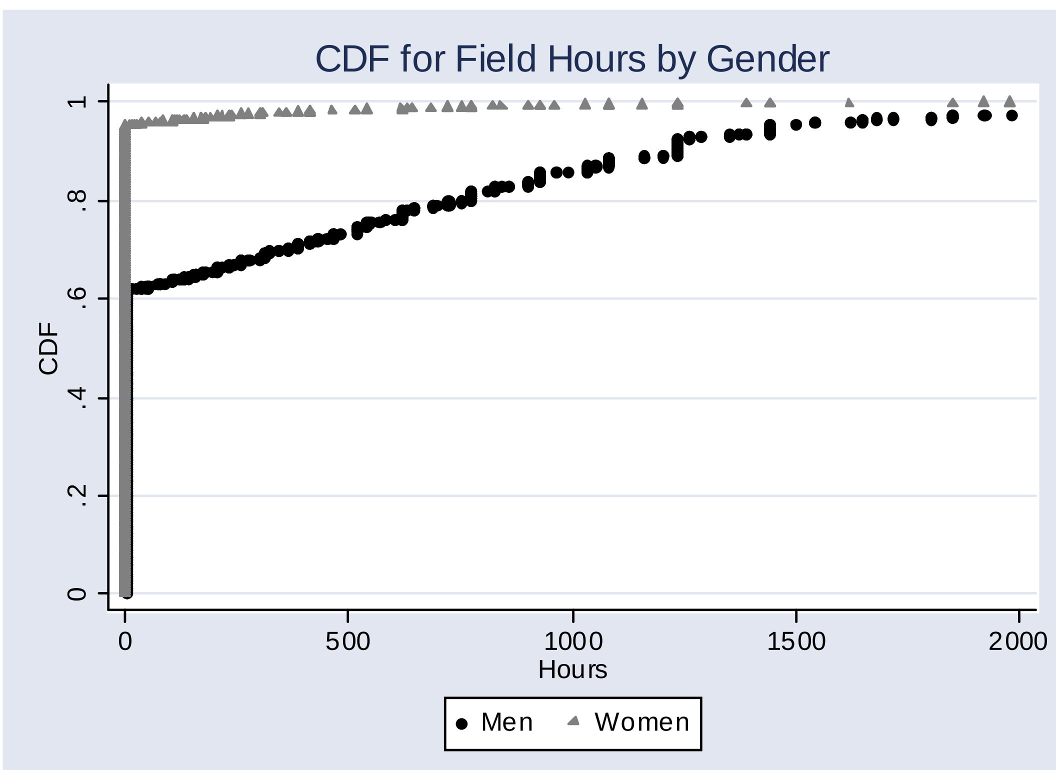

Figure 3

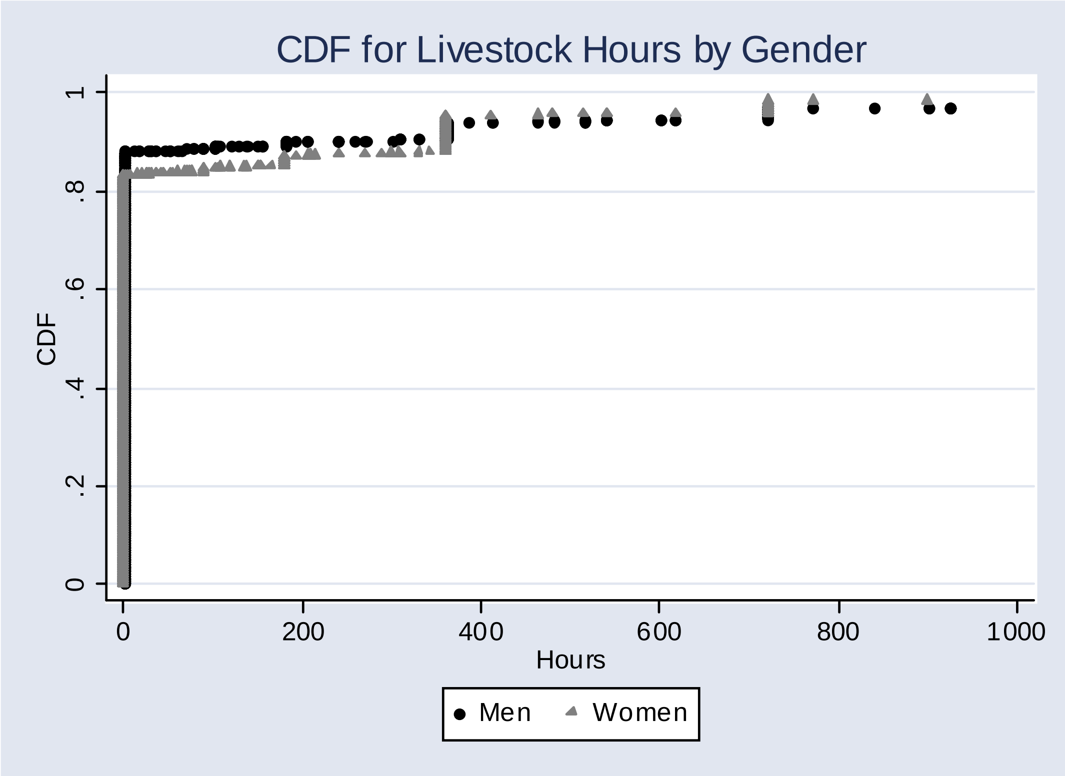

Figure 4