

# Intra-Household Labor Supply, Migration, and Subsistence Constraints in a Risky Environment: Evidence from Rural El Salvador

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April 10, 2012

## Abstract

We investigate the use of intra-household labor allocation as a means of risk coping when subsistence constraints matter in rural El Salvador. We

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\*This is a substantially revised version of an earlier paper titled, "Migration, Risk, and the Intra-Household Allocation of Labor in El Salvador." I would like to thank two anonymous referees for excellent comments. In addition, I would like to thank Sally Kwak, Ted Miguel, Ilan Noy, Raymond Roberston and seminar participants at the World Bank and IZA Conference on Employment and Development in Bonn, Germany in June, 2007 for useful comments. Finally, I am indebted to Amy Angel and Alvaro Trigueros of FUSADES for helping to clarify many important details about Salvadoran agricultural markets. The usual disclaimer applies. Address: 2424 Maile Way; Saunders Hall 533; Honolulu, HI 96822. Tele: (808) 956 - 8615. E-mail: [halliday@hawaii.edu](mailto:halliday@hawaii.edu). URL: [www2.hawaii.edu/~halliday](http://www2.hawaii.edu/~halliday).

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show that households increase the labor supply of its male members to the family farm and abroad in the US after being subjected to adverse agricultural productivity shocks. The latter is the result of a standard substitution effect, whereas the former is the result of subsistence concerns. Theoretically, these results are not at odds with each other if these events differentially impacted rich and poor households. We also show that the earthquakes of 2001 resulted in large reductions in the number of female members that were sent abroad and large increases in hours of domestic labor supplied by female members. We argue that this result is a consequence of subsistence motives since female labor supply at home increased despite lower remuneration.

Key Words: Migration, Labor Supply, Insurance, Intra-Household Allocation, Subsistence Constraints, Time Allocation

JEL Codes: J22 J61

*“There are districts in which the position of the rural population is that of a man standing permanently up to the neck in water, so that even a ripple is sufficient to drown him.”* Tawney (1966)<sup>1</sup>

## **1 Introduction**

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<sup>1</sup>This quote from *Land and Labor in China* opens James C Scott’s 1976 book *The Moral Economy of the Peasant*.

Households in less-developed countries (LDCs) often times live very close to the subsistence level and, at the same time, face a large degree of uninsured risk. In such an environment, an adverse shock such as a loss of livestock or harvest can be devastating. Because of the gravity of such events, households often are forced to rely on a menu of risk coping strategies to buffer the event's impact. One of the most readily available risk coping mechanisms is adjusting labor supply. In the most straightforward case, households will respond to an adverse productivity shock in a given sector by substituting towards a sector where their labor is relatively more expensive. In the presence of frictions, however, this may not be possible. For example, there may be rigidities in local labor markets. However, even if well functioning labor markets are accessible, these markets may not be nearby and so there will be transaction costs that must be paid to access them. In this scenario, the response of labor supply to adverse events may not accord with neoclassical theory. In particular, households may *increase* labor supply despite *lower* remuneration simply to keep their heads above water. In either scenario, the use of labor supply is an example of a "non-market" risk management mechanism.

There is a large literature in Development Economics on the use of such "non-market" mechanisms.<sup>2</sup> Part of this literature has looked at the importance of mi-

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<sup>2</sup>Some common examples include transferring funds within villages or families (Townsend (1994); Udry (1994a) ; Yang and Choi (2007); Pajaron (2011)), depleting assets (Paxson (1992); Rosenzweig

gration as both an *ex post* risk management strategy (*e.g.* Halliday (2006); Yang and Choi (2007); Pajaron (2011)) and an *ex ante* strategy (*e.g.* Paulson (2000); Rosenzweig and Stark (1989)). However, while substantial attention has been paid to migration, the use of other aspects of the intra-household allocation of labor, such as hours devoted to farming or domestic labors, has largely been ignored.

In this paper, we fill this void by developing and empirically testing a model of intra-household labor supply as an *ex post* risk coping strategy when subsistence constraints matter and when there may be productivity differences across household members. We test the model using panel data on rural households from El Salvador.<sup>3</sup> Specifically, we consider three key aspects of intra-household labor supply: labor supplied abroad, labor supplied to the household farm, and labor supplied to domestic duties. Besides contributing to the literature on risk management in LDC's, this work also adds to a fairly extensive but controversial literature on backwards bending labor supply in the presence of subsistence constraints in poorer countries (*e.g.* Barzel and McDonald (1973); Scott (1976); Frankenberg, Smith, and Thomas (2003);

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and Wolpin (1993); Udry (1994b)), increasing the labor supply (Kochar (1999)), adding household members (Frankenberg, Smith, and Thomas (2003)), and migrating (Rosenzweig and Stark (1989); Paulson (2000); Halliday (2006)). For a comprehensive survey of this literature, we refer the reader to Besley (1995).

<sup>3</sup>El Salvador is a good setting for this study due to the important role that migration plays in that country. According to the 2010 US Census, the population of the US that was born in El Salvador was about 1.2 million in 2009 (Acosta and de la Cruz (2011)). This makes Salvadorans the second most prevalent immigrant group from Latin America residing in the US after Mexicans. This is especially remarkable given that El Salvador's population was estimated to be 7.2 million in 2009.

Edmonds (2005); Jayachandran (2006); Bhalotra (2007); Bhalotra (2010)). Finally, this work further highlights the endogeneity of household composition which motivates the need to move beyond exogenous sharing rules in models of intra-household bargaining as in Basu (2006).

Our results paint an intricate picture of how Salvadoran households manage risk. In response to the earthquakes of 2001, we show that households allocated more labor to domestic duties and less labor abroad. We adopt the stance that the earthquakes *reduced* the marginal returns to labor at home. For example, it is not hard to argue that preparing a meal at home is more difficult when your kitchen is in disarray. As such, we provide evidence that subsistence was the over-arching motive behind the household's response to the earthquakes since labor supplied at home increased despite lower remuneration. In response to agricultural productivity shocks, however, matters are somewhat different. We show that households increased the number of migrants residing abroad as well as hours devoted to agricultural activities at home. Unlike the case of the earthquakes, this juxtaposition of subsistence and substitution effects is seemingly inconsistent with our model since, in it, we show that the household's response to a given shock can be motivated either by subsistence concerns or substitution concerns, but not both. However, if one adopts a more nuanced view of our results, it is still possible to reconcile these findings with theory. Regardless,

empirically, we show that backwards bending labor supply is an important aspect of the household's menu of risk coping mechanisms.

Our findings have an interesting relationship to Kochar (1999) who shows that Indian households are able to smooth consumption by working more off the farm in response to adverse productivity shocks. The increase in farm hours in response to lower productivity that we observe does not suggest that the local Salvadoran labor market is useful for insuring adverse shocks. If household members were able to freely adjust hours off-farm in response to the vagaries of farm income as in Kochar (1999), then we would not see the backwards bending labor supply that we observed.<sup>4</sup> This points towards a limited ability of the local labor market to help insure risk.<sup>5</sup>

Finally, productivity differences are a crucial aspect of how the household manages risk. In the data, we show a clear and somewhat common division of labor in which men tend to work on the farms and abroad whereas women tend to work at home. We presume that, at least partially, this reflects underlying productivity differentials.<sup>6</sup> Theoretically, when some genders supply positive labor to a given sector and others do not, small productivity changes in that sector will affect the

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<sup>4</sup>If the household could freely work off-farm at a wage  $w$ , then labor would be supplied on the farm until  $Af'(L) = w$ . If  $f(\cdot)$  satisfies standard assumptions, then reduced farm productivity will unequivocally lower farm labor.

<sup>5</sup>In an earlier version of the paper, we investigated whether or not labor off-farm in El Salvador responded to adverse productivity shocks on the farm. We provided no evidence that it did.

<sup>6</sup>We are careful not to attribute all of these differences to productivity differences, but we do believe that they play some role.

gender who is at an interior solution. Consistent with this, we show that the earthquakes exclusively affected female labor supply at home, but that agricultural shocks predominately affected male labor supply on the farm and abroad.

The balance of this paper is organized as follows. In the next section, we discuss the model. In the two subsequent sections, we discuss our data and empirical findings. Finally, we conclude.

## 2 Theory

### 2.1 Primitives

We construct a model of migration and intra-household labor supply as a means of *ex post* risk management in the presence of transactions costs and subsistence constraints. There are two time periods:  $t \in \{1, 2\}$ . The household is endowed with a measure of labor of size one which can be allocated to working on the farm ( $L_t$  for  $t \in \{1, 2\}$ ), working abroad ( $M_t$  for  $t \in \{1, 2\}$ ), or working at home ( $H_t$  for  $t \in \{1, 2\}$ ).<sup>7</sup> The marginal returns to labor while abroad are given by  $w$ . There is a

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<sup>7</sup>Readers are correct to point out that the decision to work abroad is probably lumpier than the decision to work on the household farm. Our main motivation for assuming that all forms of household labor can be adjusted at very small margins is to ensure tractability of the model. However, one defense of our treatment of migration is that, while individuals are not divisible, time is. Hence, households can potentially adjust migrants at smaller margins by reducing their time abroad.

migration cost which we denote by  $\tau$ . On the farm, returns to labor are determined by an increasing and concave production function which we denote by  $A_t F(\cdot)$  for  $t \in \{1, 2\}$  where  $A_t \in (0, \infty)$  is a productivity parameter. In period one, second period productivity is unknown and, so is stochastic. Similarly, home production is determined by an increasing and concave function denoted by  $B_t G(\cdot)$  for  $t \in \{1, 2\}$  where  $B_t \in (0, \infty)$ . The household consumes a consumption good ( $C_t$  for  $t \in \{1, 2\}$ ) and household services ( $P_t$  for  $t \in \{1, 2\}$ ). The consumption good can either be produced on the farm or purchased with migrant wages. We assume that utility from consumption and household services is additively separable and is determined by two increasing and concave utility functions denoted by  $U(\cdot)$  and  $V(\cdot)$ , respectively.

We make additional assumptions which are divided into two categories. Assumptions T1-T3 are straightforward and will be invoked in the body of the paper. Assumptions A1-A2 are technical and will be used in the Appendix where we derive some of the results discussed in the text.<sup>8</sup>

$$(T1) \quad \tau = w$$

$$(T2) \quad F'(0) = \infty$$

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<sup>8</sup>Assumption A1 restricts  $U(\cdot)$  and  $V(\cdot)$  to the class of utility functions with decreasing relative risk aversion. Note that the literature on labor supply in the presence of subsistence constraints typically employs specialized utility functions (*e.g.* Barzel and McDonald (1973) and Bhalotra (2007)). Our paper is no different in this regard.

$$(T3) \quad G'(0) = \infty$$

$$(A1) \quad r(C) \equiv -C \frac{U''(C)}{U'(C)} \text{ is decreasing in } C$$

$$s(P) \equiv -P \frac{V''(P)}{V'(P)} \text{ is decreasing in } P$$

$$(A2) \quad r(C) = \infty \text{ for } C = 0 \text{ and } r(C) = 0 \text{ for } C = \infty$$

$$s(P) = \infty \text{ for } P = 0 \text{ and } s(P) = 0 \text{ for } P = \infty$$

## 2.2 Optimal Labor Supply

We solve the model via backwards induction.<sup>9</sup> First, we note that in the second period there will be no immediate returns to migration due to T1 and so, we will have that  $M_2 = M_1$ .<sup>10</sup> Accordingly, in the second period, after observing  $A_2$  and  $B_2$ , the household solves

$$\max_{\{L_2, H_2\}} U(C_2) + V(P_2)$$

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<sup>9</sup>This is a model of *ex post* risk management in which the household first observes  $(A_t, B_t)$  and then makes their labor allocation and consumption choices for that period.

<sup>10</sup>Southward migration is a theoretical possibility, but we do not consider it in this section. Our reasons for this are threefold. First, we do not believe that it is likely that a migrant would leave in period one, pay the migration costs and then return in the next period having earned nothing abroad. Second, one would expect that wages in the US would be high enough so that a migrant would choose to stay for the second period. Finally, in the data, northward migration is about twice as common as return migration.

subject to

$$M_1 + L_2 + H_2 = 1$$

$$C_2 = A_2 F(L_2) + wM_1$$

$$P_2 = B_2 G(H_2)$$

Along with the time constraint, the household's labor supply decision is determined by

$$A_2 F'(L_2) U'(A_2 F(L_2) + wM_1) = B_2 G'(H_2) V'(B_2 G(H_2))$$

which is an intra-temporal condition that equates the marginal benefits of working on the farm to its marginal costs. The two corner solutions (*i.e.*  $L_2 = 1 - M_1$  and  $L_2 = 0$ ) are ruled out by T2 and T3.<sup>11</sup>

Moving back to the first period, after observing  $A_1$  and  $B_1$ , the household solves

$$\max_{\{L_1, M_1, H_1\}} U(C_1) + V(P_1) + E[J(A_2, B_2, M_1)]$$

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<sup>11</sup>As is obvious from this first order condition, separation does not obtain in this model since production and consumption decisions are tied. This is driven by the presence of the migration cost. In its absence, the model becomes static and the household will employ labor on the farm up until  $AF'(L) = w$  in both periods. For an excellent discussion of separation in farm household models and how to test for it, we refer the reader to Benjamin (1992).

subject to

$$M_1 + L_1 + H_1 = 1$$

$$C_1 = A_1 F(L_1)$$

$$P_1 = B_1 G(H_1)$$

where

$$J(A_2, B_2, M_1) = U(A_2 F(L_2^*) + wM_1) + V(B_2 G(1 - L_2^* - M_1))$$

and  $L_2^*$  is the optimal second period choice for labor supply. The household's optimal labor supply on the farm in the first period will be characterized by an intra-temporal condition

$$A_1 F'(L_1) U'(A_1 F(L_1)) = B_1 G'(1 - L_1 - M_1) V'(B_1 G(1 - L_1 - M_1)). \quad (1)$$

Once again, corner solutions are ruled out by T2 and T3. The optimal migration

choice is given by

$$\begin{aligned}
 wE [U'(A_2F(L_2^*) + wM_1)] &= B_1G'(1 - L_1 - M_1) V'(B_1G(1 - L_1 - M_1)) \quad (2) \\
 &+ E [(B_2G'(1 - L_2^* - M_1) V'(B_2G(1 - L_2^* - M_1)))]
 \end{aligned}$$

at an interior solution and

$$\begin{aligned}
 wE [U'(A_2F(L_2^*)))] &< B_1G'(1 - L_1) V'(B_1G(1 - L_1)) \quad (3) \\
 &+ E [(B_2G'(1 - L_2^*) V'(B_2G(1 - L_2^*)))]
 \end{aligned}$$

at a corner in which  $M_1 = 0$ .

Note that there are two scenarios in which households will be at a corner solution for first period migrants. The first is when the household expects high returns to agriculture in the second period. This will obviate the need for migrant wages. The second is that the household experiences a very negative productivity shock in the first period. As we will see, this will drive first period farm labor supply *higher* which will raise the utility costs of migration.

## 2.3 Comparative Statics

We now discuss how first period labor allocation is impacted by movements in  $A_1$  and  $B_1$ . The main results are summarized by the following proposition and its corollary. We derive the comparative statics for the case in which  $M_1 > 0$ .<sup>12</sup> The proofs are in the Appendix.

**Proposition 1 (*Part 1 - Agricultural Shocks*)** *Under our stated assumptions, we will have that*

$$\frac{\partial L_1}{\partial A_1} = \Gamma_0(A_1) + \Gamma_1 \frac{\partial M_1}{\partial A_1} \quad (4)$$

where  $\Gamma'_0(A_1) > 0$ ,  $\Gamma_0(A_1) < 0$  for  $A_1$  close to zero,  $\Gamma_0(A_1) > 0$  for  $A_1$  sufficiently large and  $\Gamma_1 \in [-1, 0]$ .

**(*Part 2 - Home Productivity Shocks*)** *Also, we will have that*

$$\frac{\partial H_1}{\partial B_1} = \Lambda_0(B_1) + \Lambda_1 \frac{\partial M_1}{\partial B_1}$$

where  $\Lambda'_0(B_1) > 0$ ,  $\Lambda_0(B_1) < 0$  for  $B_1$  close to zero,  $\Lambda_0(B_1) > 0$  for  $B_1$  sufficiently large and  $\Lambda_1 \in [-1, 0]$ .

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<sup>12</sup>We acknowledge that in our data about 75% of households do not have any migrants residing abroad. However, the marginal effects that we estimate later will reflect both the extensive and intensive margins. So, these comparative statics will be relevant for what is to come.

**Corollary 2 (Part 1 -Agricultural Shocks)** Under our stated assumptions and at an interior solution for  $M_1$ , we will have that  $\frac{\partial M_1}{\partial A_1} < 0$  for  $\Gamma_0(A_1) > 0$  and  $\frac{\partial M_1}{\partial A_1} > 0$  for  $\Gamma_0(A_1) < 0$ .

**(Part 2 - Home Productivity Shocks)** Also, at an interior solution for  $M_1$ , we will have that  $\frac{\partial M_1}{\partial B_1} < 0$  for  $\Lambda_0(B_1) > 0$  and  $\frac{\partial M_1}{\partial B_1} > 0$  for  $\Lambda_0(B_1) < 0$ .

These results imply that the household's response to first period risk will divide neatly into two regimes. We will discuss these for movements in  $A_1$ . However, the discussion is the same for movements in  $B_1$ .

In the first regime,  $A_1$  is large. This implies that  $\Gamma_0(A_1)$  is positive and that  $\frac{\partial M_1}{\partial A_1}$  is negative. Hence, equation (4) implies that  $\frac{\partial L_1}{\partial A_1}$  is positive. Sufficiently well-off households will respond to negative farm productivity shocks by migrating more and working less on the farm. We term this the *substitution regime* since these are standard substitution effects.

In the second,  $A_1$  is very small. This implies that  $\Gamma_0(A_1)$  is negative and that  $\frac{\partial M_1}{\partial A_1}$  is positive. Consequently,  $\frac{\partial L_1}{\partial A_1}$  will be negative. Households that are barely scraping by will respond to a negative agricultural shock by working more on the farm and migrating less. We term this the *subsistence regime*. These effects are driven by the fact that, at low consumption levels, the marginal utility of consumption will be extremely high. Hence, lower productivity in the fields will have to be dealt with

by increased farm labor since migration does not yield an immediate return.

This discussion is summarized in Figure 1. For  $A_1$  near zero, we will have that  $\frac{\partial L_1}{\partial A_1}$  is negative. We can also expect that  $M_1 = 0$  due to condition (3).<sup>13</sup> Once  $A_1$  is sufficiently high, the household will begin to migrate. However, if  $\frac{\partial M_1}{\partial A_1}$  is positive then Proposition 1 guarantees that  $\frac{\partial L_1}{\partial A_1}$  will be negative. Next, we will have that  $\frac{\partial M_1}{\partial A_1} = \frac{\partial L_1}{\partial A_1} = 0$  for  $A_1 = A^*$ . After this,  $\frac{\partial M_1}{\partial A_1}$  will be negative and  $\frac{\partial L_1}{\partial A_1}$  will be positive. Hence, the subsistence regime occurs to the left of  $A^*$  and the substitution regime occurs to its right. Note that an implication of this proposition and its corollary is that  $\frac{\partial M_1}{\partial A_1}$  and  $\frac{\partial L_1}{\partial A_1}$  must be of the opposite sign.

## 2.4 Intra-Household Productivity Differences

We conclude the theory section by discussing some extensions of the model that allow for intra-household productivity differences. Specifically, we now assume that the household has two members, a female (which we denote with an  $f$  superscript) and male (which we denote with an  $m$  superscript), each of whom allocates her/his labor between farm labor, working abroad and home production. Accordingly, the

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<sup>13</sup>Low values of  $A_1$  imply that  $L_1$  is high and so that  $H_1$  is low. Hence,  $V'(H_1)$  will be very high which makes corners for migration more likely.

household's time constraints are given by

$$M_t^j + L_t^j + H_t^j = 1 \text{ for } t \in \{1, 2\} \text{ and } j \in \{m, f\}.$$

Production on the farm and at home is determined by

$$A_t F(L_t^m, L_t^f) = A_t \left[ \alpha^m f(L_t^m) + \alpha^f f(L_t^f) \right]$$

and

$$B_t G(H_t^m, H_t^f) = B_t \left[ \beta^m g(H_t^m) + \beta^f g(H_t^f) \right],$$

respectively. The productivity shocks are given by  $A_t$  and  $B_t$  as before. The parameters  $(\alpha^m, \alpha^f)$  and  $(\beta^m, \beta^f)$  determine relative productivity of female and male labor on the farm and at home. The functions  $f(\cdot)$  and  $g(\cdot)$  are assumed to be increasing and concave. Finally, male and female labor abroad is remunerated with  $\omega^m$  and  $\omega^f$ .

To illustrate our desired points in this subsection, we are able to bypass the formalities of Assumptions T1-T3 and A1-A2 from earlier. However, we will maintain that  $\tau \geq \omega^m, \omega^f$  which guarantees that there will be no second period migration. Also, we will no longer require that  $g'(0)$  and  $f'(0)$  are infinite. We assumed this earlier to rule out corner solutions which cleaned up the analysis. However, corner

solutions will now be important, so we will relax it.

The productivity parameters determine the relative allocations of males and females in each sector. To illustrate, if we take the intra-temporal conditions from the first time period for males and females and if both genders are at interior solutions, then we obtain that

$$\frac{\alpha^m f'(L_1^m)}{\alpha^f f'(L_1^f)} = \frac{\beta^m g'(H_1^m)}{\beta^f g'(H_1^f)}.$$

Clearly, increasing productivity of a gender either on the farm or at home will increase the presence of that gender in that sector.

If the productivity differences are sufficiently different, then we will see that, within a sector, one gender is at a corner whereas the other is not. For example, if productivities are sufficiently different then we will see that

$$\omega^m E[U'(C_2)] > \beta^m [B_1 g'(H_1^m) V'(P_1) + E[(B_2 g'(H_2^m)) V'(P_2)]]$$

and

$$\omega^f E[U'(C_2)] < \beta^f [B_1 g'(H_1^f) V'(P_1) + E[(B_2 g'(H_2^f)) V'(P_2)]]$$

so that males are at a corner for home production and females are at a corner for migration. This will tend to happen when  $\frac{\omega^m}{\omega^f} > \frac{\beta^m}{\beta^f}$  so that males are relatively more productive abroad and females are relatively more productive at home. Importantly,

when a gender is at a corner in a given sector, the marginal effects of a productivity shock (*i.e.* a change in either  $A_t$  or  $B_t$ ) will be zero as illustrated in Figure 1.

There is some empirical content to this aspect of the model. First, the theory suggests that we can look at the amount of labor allocated to different sectors by each gender and make inferences about comparative advantage within the household.<sup>14</sup> Second and more importantly, relative productivities will condition the labor supply response to a shock. To illustrate, consider working abroad. If males are much more productive abroad than females, then the household should be at a corner solution for females and at an interior solution for males. We will then have that  $\frac{\partial M^m}{\partial A} \neq 0$  and  $\frac{\partial M^f}{\partial A} = 0$ . In the presence of large productivity differences, we should see larger effects of productivity shocks for the more productive gender.

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<sup>14</sup>Note that we are not testing whether or not the observed allocations are due to productivity differences or discrimination. 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 is provided by 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) lends credence to our model, which assumes that labor allocation differences between genders are due to comparative advantage.

## 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 Salvadoreña para el Desarrollo Económico y Social (FUSADES).<sup>15</sup> We employ three waves of the panel that were fielded in the beginning of 1998, 2000, and 2002. The surveys had recall periods of 1997, 1999, and 2001. The data contain identifiers that enable us to track households across time. Because some key variables were only available for 1999 and 2001, our regressions only use these years. However, the 1997 data were still used in the analysis to construct lags of some variables. Descriptive statistics and variable definitions are given in Table 1.

#### 3.1.1 Migrants

The BASIS data contain information on the number of migrants within the household. We define a migrant to be any household member who, at the time that the survey was administered, was residing in the United States or Canada.<sup>16</sup> The survey

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<sup>15</sup>For a more thorough discussion of these data including an analysis of panel attrition, we refer the reader to Halliday (2006).

<sup>16</sup>A household member is defined as someone who is tied to the family by blood or marriage.

does not distinguish where a specific migrant was residing, but we believe that it is reasonable to assume that the vast majority of migrants are residing in the United States.<sup>17</sup> Because of this, for the remainder of the paper we refer to all migrants as residing in the United States.

### **3.1.2 Labor Supply Within the Household**

We also employ data on intra-household labor supply. 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 self-consumption.” We call the second “livestock labor,” which the survey defines as “Cuido de animales para venta o autoconsumo” or “Care of animals for sale or self-consumption.”<sup>18</sup> Finally, we call the third “domestic labor,” which the survey defines as “Labores domésticas (preparación de alimentos, limpieza, cuidado de niños y enfermos)” which in English

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<sup>17</sup>Based on numbers from the Canadian government, 115 Salvadorans legally entered Canada to work in 2009. Related, there were 825 Salvadoran permanent residents in the same year. (Source: <http://www.cic.gc.ca/english/resources/statistics/facts2009/>)

<sup>18</sup>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 an activity separate 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 that involve crops.

is “Domestic labor (preparation of food, cleaning, care of children and the sick).” This survey instrument allowed us to measure hours allocated to these activities at the individual level. We then summed these individual level variables by household to obtain household level variables for hours worked by all female and male family members in each of these intra-household sectors. Table 1 displays the summary statistics on these variables at the household level and Table 2 displays summary statistics at the individual level.

### **3.1.3 Exogenous Shocks**

Measures of exogenous shocks come from two sources: poor agricultural conditions in 1999 and 2001 and the earthquakes of 2001. These data were not available in the 1997 data. The agricultural shocks are dummy variables indicating income loss from either harvest or livestock loss.<sup>19</sup> In the 1999 and 2001 panels, 25.99% of all households reported experiencing at least one agricultural shock. The prevalence of these shocks was slightly higher in the 2001 data, presumably due to a drought that occurred in that year. Our earthquake shock is an index corresponding to the (log

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<sup>19</sup>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 it reported losing all or part of its harvest and that this event resulted in a lower household income. In 2001, the household was defined to have experienced a harvest loss if it reported that the value of its harvest was less than normal as a consequence of a drought that occurred in 2001. Unfortunately, because the 1999 survey did not solicit the actual cause of the harvest loss, it is not possible to have comparable measures of harvest losses in 1999 and 2001.

of) the monetary value of damage sustained from two earthquakes that occurred on January 13 and February 13, 2001 which is the beginning of the 2001 recall period. The earthquakes registered 7.6 and 6.6 on the Richter Scale, respectively, and killed a total of 1159 people. Nicolas and Olson (2001) estimate that the disasters left over 1 million people without adequate shelter by February 2001.

As in Udry (1994a) and Udry (1994b), all of the shocks we consider are based on self-reports. Recently some researchers have shied away from using 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, because rainfall data are collected at the regional level by a department or a *municipio*, this precludes the use of many location dummies and raises concerns about omitted variables. In contrast, the shocks we use vary within geographic units.<sup>20</sup> Finally, we provide evidence in this paper and in Halliday (2006) that mitigates many of the endogeneity concerns that have been raised about self-reported shocks.<sup>21</sup>

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<sup>20</sup>For example, Halliday (2006) provides nonparametric density estimates of earthquake damage within departments and shows that there is considerable intra-regional variation.

<sup>21</sup>For example, in this paper, we conduct falsification tests in which we take the shock from a given year and merge it into the dataset by household for the other year. So, if  $y_{01}$  and  $y_{99}$  are dependent variables for 2001 and 1999 and  $s_{01}$  and  $s_{99}$  are the shocks defined analogously, we regressed  $y_{01}$  on  $s_{99}$  and  $y_{99}$  on  $s_{01}$  to test for false treatments. In addition, in Halliday (2006), we investigated if non-random panel attrition biased our results (in Table 6), tested if the shocks were

### 3.1.4 Timing of Events in the Survey

At this point, we discuss the timing of events in our survey as it pertains to the econometric results that we will present. The dependent variables that we employ are changes across successive surveys in the stock of either the number of migrants in the household or the number of hours allocated to various sectors within the household. The number of migrants is measured at the point-in-time in which the survey was administered (which was the start of 1998, 2000, or 2002), but the variables on labor supply within the household measure their quantities during the survey's recall period which is one year (either 1997, 1999, or 2001). The variables on agricultural shocks measure whether or not these events took place at a point during the recall period (either 1999 or 2001) and the earthquake shock variable measures damage caused by earthquakes which occurred in January and February of 2001.

Now, consider the change in the migrant stock between the surveys with recall periods 2001 and 1999 (which were administered in 2002 and 2000). Both the agricultural and earthquake shocks occurred precisely between both migrant measurements. So, a regression of the change in migrant stocks between 2002 and 2000 on the shocks from 2001 provides a very clean test of whether or not these events induced a change in the stock of migrants in the US.

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predicted by baseline household characteristics (in Table 10), and conducted falsification tests (in Table 11).

In contrast to our migrant measures, the labor supply variables that we employ measure hours employed at home or on the farm during the recall period, not after it. So, a difference across the surveys with recall periods 1999 and 2001 in any one of our hours measures delivers the change in hours between 1999 and 2001. Because the exogenous shocks from the survey with the 2001 recall period could have taken place at any point during 2001, the labor supply variables do not provide a test that is as clean as the migrant measures. This caveat should be borne in mind as we proceed. However, the earthquakes occurred at the very start of the 2001 recall period and, so this caveat is less pertinent for the results on the earthquake's effects.

## **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, Sobek, Alexandar, Fitch, Goeken, Hall, King, and Ronnander (2004)). We define a Salvadoran migrant as a US resident who resided in El Salvador five years prior to being interviewed. There are 5,251 such individuals in these data. Because we are interested in quantifying hourly wage differentials by gender, we further restrict the sample to working-age people defined to be 20 years or older. This further reduces the sample to 3,738. We employ variables on hourly wages, age, years in the United States, employment status, citizenship

status, and education. Hourly wages were constructed by dividing the respondent's total wage income in the year by the number of hours per week that the respondent reported to work multiplied by 52. Summary statistics are reported in Table 3.

## **4 Testing the Theory**

We now provide an empirical test of the theory. We begin by looking at some descriptive statistics on intra-household allocations and wages in the US. The idea of this exercise is to use this descriptive evidence in conjunction with the model to make some inferences about intra-household productivities. In addition, we will use this evidence to better understand which genders should be most impacted by exogenous shocks. Next, we will investigate the effects of exogenous events on intra-household allocations. This discussion will emphasize establishing whether or not there is a causal relationship between the shocks and household behavior. After that, we will discuss how our findings accord with the theory.

### **4.1 Intra-Household Allocations and Productivity**

#### **4.1.1 In the United States**

We begin by investigating male-female differentials in wages and employment status among Salvadoran migrants in the US. A perusal of Table 3 reveals two facts. First is that the average US wage of Salvadoran women, including women who are not in the labor force, is \$2.16 less than the wage of a Salvadoran male. Second, a far greater share 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.<sup>22</sup> 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 2. 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 calculate that a total of  $0.19 * 0.5361 = 0.1019$  females per household 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

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<sup>22</sup>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 (1993) for a discussion of these motives in the case of Mexican migration.

migrants as female migrants per household.

In Table 4, 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).<sup>23</sup> It can be seen that even after we adjust for 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 (column 5) and \$3.33 (column 6).<sup>24</sup>

#### 4.1.2 In El Salvador

We now turn to how the distribution of hours worked in various household activities differs across genders in El Salvador. The activities that we consider are field, livestock, and domestic labor, which were discussed in Section 3.1.2. We calculate

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<sup>23</sup>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). 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 homoskedasticity. For additional opinions on this, we refer the reader to Deaton (1997).

<sup>24</sup>We bootstrapped the standard errors in column 6 when CLAD was employed using 100 replications.

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 by an individual. The results of this exercise are displayed in Figures 3, 4, and 5 for field, livestock, and domestic labor, respectively. Consistent with Table 2, these results indicate, perhaps not surprisingly, that field labor is largely (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.

## 4.2 Exogenous Shocks and Intra-Household Allocations

### 4.2.1 Migration

To investigate the effects of exogenous shocks on migration, we consider a model that is similar to that in Halliday (2006). With some modification of notation, it is given by

$$\Delta M_{h,t}^j = \alpha^j + \zeta_t^j + \omega'_{h,t} \delta^j + R'_h \rho^j + X'_{h,t-1} \beta + \varepsilon_{h,t}^j \text{ for } j \in \{M, F\} \quad (5)$$

where  $\Delta M_{h,t}^j$  is the change in the stock of male or female migrants across time periods,  $\zeta_t^j$  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 for the number of households members in certain age/gender cells.<sup>25</sup> Two sets of location dummies are employed: department dummies of which there are 14 and *municipio* dummies of which there are 173.<sup>26</sup> To address the obvious 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 that 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 5 reports our results for male migration and Table 6 reports our results for female migration.

The first two columns of Table 5 display estimation results when the dependent variable is total migration (*i.e.* the sum of male and female migration) as a reference. In column 1, we see that the agricultural shocks had a positive and significant impact on migration, whereas the earthquakes had a negative and significant impact on mi-

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<sup>25</sup>Note that jointly estimating these models for men and women does *not* affect consistency. Also, there are no efficiency gains when estimating linear models. In a SUR model, equation-by-equation OLS is numerically equivalent to GLS when the regressors are the same in all the equations.

<sup>26</sup>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.

gration. 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.<sup>27</sup> 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. Overall, these results suggest that there is a causal effect of both the agricultural shocks and the earthquakes on migration.

Columns three through six of Table 5 use male migration as the dependent variable. In all four columns, we see that adverse agricultural shocks had a positive and significant impact on migration. All tests of joint significance have  $p$ -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.<sup>28</sup> We must emphasize

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<sup>27</sup>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.

<sup>28</sup>While this procedure does mitigate omitted variables concerns, it also eliminates a substantial

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 mitigates concerns of omitted variables bias. In 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 6, 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 be seen by the lower point-estimates and  $F$ -tests at 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 for women 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.

#### 4.2.2 Labor at Home and on the Farm

We now turn to the effects of stochastic shocks on the allocation of labor within the household in El Salvador. We define  $H_{h,t}^{j,s}$  to be the number of labor hours devoted

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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.

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 then estimate a similar model to equation (3) except that we use  $\Delta H_{h,t}^{j,s}$  as the dependent variable using OLS. Our core results are reported in Table 7.

First, consider the coefficient estimates on the earthquake damage index. In the last column of the table, 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 is that a 1% increase in earthquake damage is associated with an increase of 1.54 hours devoted to domestic labor. This implies that a one standard deviation increase in earthquake damage resulted in a 584 hour increase in hours devoted to domestic work by women during the year. In contrast, in column five, 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, 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 toward home production.

Next, consider the effects of the two agricultural shocks on hours. 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. However, livestock losses had no effects on field hours, nor did harvest losses have any effects on livestock hours for either men or women.

Towards the bottom of the table, we report the results of falsification tests that are similar to those in column 2 of Table 5. We observe that the  $p$ -values on the  $F$ -tests are all quite high and always greater than 10%. This mitigates concerns that the shock variables are picking up omitted variables.

We conclude this sub-section with two robustness checks. In the first, we estimate models similar to those in Table 7 except that now we employ 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) as the dependent variable.<sup>29</sup> These results are reported in Table 8. Overall, our conclusions are unaffected, although we do see that the coefficient on livestock loss is diminished in column 3. In the second robustness check, we re-estimate the same regression, but with *municipio* dummies *in lieu* of department dummies. These results are reported in Table 9. Once again, our conclusions are unaffected and, if anything, are stronger.

### 4.2.3 A Caveat about Statistical Significance

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<sup>29</sup>We define an adult to be anyone 16 years of age or older.

We must emphasize that many of the specifications that we estimated pushed the data quite hard. Aside from small sample sizes and measurement errors in our key explanatory variables, we also employed a variety of fixed effects estimators that, while great for controlling for many omitted variables, also reduced much of the variation in the data. As such, we admonish the reader to bear two things in mind. First, they should adjust their critical values of null hypotheses downwards for the fact that we have a small sample size and somewhat noisy data. This is the view of Leamer (1978) (pp. 100-120) and echoed in Deaton (1997) (pp. 130-131) and is rooted in the observation that Type II errors will be more prevalent in small samples, but Type I errors will be more common in large samples. While we do not formally use the procedure outlined in Leamer, we suggest that readers implement its basic premise as a rule-of-thumb. Second, for many of the specifications, we reported tests of the joint null that two or three coefficients are zero. This test is more powerful than simply looking at separate  $t$ -statistics and, so greater emphasis should be placed on it.

### **4.3 Reconciliation with the Theory**

To reconcile the empirical findings with our model, we first use the descriptive evidence on intra-household allocations in Section 4.1 to provide us with an idea of

which genders should be most impacted by exogenous shocks. The evidence presented shows that women are more likely than men to be at corner solutions for working abroad and in the fields. On the other hand, equal percentages of both genders did not tend to the livestock. The discussion in Section 2.4 then suggests that we should see that the harvest losses should have larger impacts on male migration and field hours, but that livestock losses should have similar effects on male and female migration and livestock hours.

This was borne out in our empirical results. Harvest losses had large and significant effects on male migration and male field hours. However, they had smaller and marginally significant effects on female migration and a null effect on female field hours. Interestingly and consistent with the descriptive evidence on intra-household labor allocations, we found that the livestock losses had similar effects on migration and livestock hours for both genders.

The effects of the earthquakes will depend in large part on how they impacted the household. In Halliday (2006), we argued that earthquakes by-and-large increased labor demand at home via a mechanism much like the one formalized in the model in which a large shock can drive up the marginal utility of home production. We also ruled out alternative explanations including that the earthquakes dried up financing. Accordingly, we would expect the earthquakes to have increased the demand for

home production primarily for females given that men were more likely to be at a corner for home production. This is precisely what we saw in the empirical results. Earthquake damage only impacted female migration and domestic hours.

It is also important to bear in mind that damage sustained from the earthquakes most likely reduced the returns to labor at home. For example, activities such as laundering clothes and cooking were probably more difficult for households that were heavily impacted by the disaster. As such, the responses to the earthquakes appear to have been very much in line with backwards bending labor supply since women worked more despite lower remuneration.

Finally, the question of whether the subsistence or the substitution regime predominates remains. First, we saw that the earthquakes resulted in *less* female migration and *more* female domestic hours. This coincides very nicely with the theory and suggests that the earthquakes raised the marginal utility of the home produced good to point where the household had to pull females from abroad and employ them in home production. This was most likely facilitated by the fact that women earn less and are more likely to be unemployed when abroad. In addition, the CDF of domestic hours suggests that women may have a comparative advantage in home production, although we are cognizant that other factors may be at play here. Accordingly, the marginal effects of the earthquakes are consistent with the

household being in the subsistence regime for home production.

In contrast, the agricultural shocks increased both migration and hours devoted to crops and livestock, particularly, for males. The positive effect of the shocks on migration can be rationalized by a simple substitution story. On the other hand, the positive responses of field and livestock hours suggest that the household was operating at a point where the marginal utility of consumption was very high and, so an adverse agricultural production shock increased hours devoted to agricultural activities. This is consistent with other evidence of backwards bending labor supply curves in subsistence environments (*e.g.* Frankenberg, Smith, and Thomas (2003); Edmonds (2005); Jayachandran (2006); Bhalotra (2007); Bhalotra (2010)). However, theory suggests that a positive male migratory response to an adverse agricultural shock *must* be accompanied by employing fewer men in the fields in response to the same shock and so, the substitution and subsistence effects cannot coexist in theory. Hence, unless one takes a more nuanced view of the data, the observed responses to the agricultural shocks pose a puzzle when reconciled with the theory.

One can alleviate this dissonance if adverse agricultural conditions had heterogeneous effects on prices *within* the survey period. For example, a shock may initially reduce agricultural returns and this may, in turn, increase farm labor supply out of subsistence concerns. Subsequently, price expectations may increase due to lower

supply if the shocks had broader effects beyond the household. In response the household may then migrate more as shown in Figure 1.<sup>30</sup>

Alternatively, the effects of the agricultural shocks on migration and farm labor may be reflecting effects on different types of households. For example, if more well-off households are able to have migrants abroad and less-well off households are not then one might expect the agricultural shocks to have had positive effects on richer households and null effects on poorer households. Taken together this suggests that a significant and positive effect may be found in the data despite null effects for a large percentage of people.<sup>31</sup> Similarly, more well-off households may have had less attachments to their farms than poorer households. By a similar reasoning, the agricultural shocks may have had positive effects for poorer families and null effects for richer families. Together, we may still expect to see a positive and significant effect on agricultural hours.

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<sup>30</sup>I thank a referee for pointing this out.

<sup>31</sup>This is consistent with Halliday (2006) who showed that households with more land were more likely to have migrants residing abroad suggesting that liquidity constraints may matter to some extent. However, note that, as was pointed out in that paper, this is not at loggerheads with one of that paper's punchlines which was that the 2001 earthquakes did not stunt northward migration as a consequence of their effects on migration financing.

## 5 Conclusions

We investigated how the intra-household allocation of labor responds to productivity shocks when subsistence constraints matter. To do this, we constructed a simple model with multiple sectors that allowed for subsistence behavior. We then tested some of the implications of this model using panel data from El Salvador.

We showed that damage sustained 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. We argued that this is very much subsistence behavior since households that sustained damage due to the disaster most likely saw the marginal returns to home production decrease. Thus, it appears that it was the women who dealt with the aftermath of the disaster.

Next, we showed that adverse shocks in the agricultural sector were met by increases in the number of male migrants living in the US and by increases in male hours devoted to agricultural activities. These findings are consistent with both subsistence and substitution behavior. Unlike the household's response to the earthquakes, these findings did not accord entirely with the theory since they imply that

subsistence and substitution behavior cannot exist at the same time, although a more careful reading suggests that these results can coexist with theory.

Moving forward, we suggest the following future research. Our results suggest that the gender composition of the household is far from exogenous. At the same time, it is not hard to argue that this will affect intra-household bargaining. As such, researchers may want to further investigate extensions to the canonical model of intra-household allocation from Browning, Bourguignon, Chiappori, and Lechene (1994) that account for endogenous sharing rules as in Basu (2006).

## 6 Mathematical Appendix

### Proof of Proposition 1.

**(Part 1 - Agricultural Shocks)** If we differentiate equation (1) with respect to  $A_1$ , we obtain

$$\begin{aligned}
 & F'(L_1)U'(C_1) + A_1F''(L_1)U'(C_1)\frac{\partial L_1}{\partial A_1} + \\
 & A_1F'(L_1)U''(C_1)\left[A_1F'(L_1)\frac{\partial L_1}{\partial A_1} + F(L_1)\right] = \\
 & \left(B_1G''(H_1)V'(P_1) + [B_1G'(H_1)]^2V''(P_1)\right)\left[-\frac{\partial L_1}{\partial A_1} - \frac{\partial M_1}{\partial A_1}\right]
 \end{aligned}$$

which can be written as

$$\begin{aligned} \frac{\partial L_1}{\partial A_1} & \left[ \begin{array}{l} A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) + \\ B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) \end{array} \right] = \\ & -A_1 F'(L_1) U''(C_1) F(L_1) - F'(L_1) U'(C_1) - \\ & \left( B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) \right) \frac{\partial M_1}{\partial A_1} \end{aligned}$$

or

$$\frac{\partial L_1}{\partial A_1} = \Gamma_0(A_1) + \Gamma_1 \frac{\partial M_1}{\partial A_1}$$

with

$$\begin{aligned} \Gamma_0(A_1) & \equiv \frac{-F'(L_1) U'(C_1) - A_1 F'(L_1) U''(C_1) F(L_1)}{\left[ \begin{array}{l} A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) + \\ B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) \end{array} \right]} \\ \Gamma_1 & \equiv \frac{-(B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1))}{\left[ \begin{array}{l} A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) + \\ B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) \end{array} \right]}. \end{aligned}$$

We realize that  $\Gamma_1$  is also a function of  $A_1$  but we are not explicit about this to economize on notation. Note that the denominator of  $\Gamma_0$  is unambiguously negative

and so we will have that

$$\Gamma_0(A_1) < 0 \text{ iff } r(C_1) > 1$$

$$\Gamma_0(A_1) > 0 \text{ iff } r(C_1) < 1.$$

Because of A1 and A2, we will have that  $\Gamma'_0(A_1) > 0$ ,  $\Gamma_0(A_1) < 0$  for  $A_1$  close to zero and  $\Gamma_0(A_1) > 0$  for  $A_1$  large. Finally, by inspection, we can see that  $\Gamma_1 \in [-1, 0]$ .

**(Part 2 - Home Productivity Shocks)** If we differentiate equation with respect to  $B_1$ , we obtain

$$\begin{aligned} & G'(H_1) V'(P_1) + B_1 G''(H_1) V'(P_1) \frac{\partial H_1}{\partial B_1} + \\ & B_1 G'(H_1) V''(P_1) \left[ G(H_1) + B_1 G'(H_1) \frac{\partial H_1}{\partial B_1} \right] = \\ & \left( A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) \right) \left[ -\frac{\partial H_1}{\partial A_1} - \frac{\partial M_1}{\partial A_1} \right]. \end{aligned}$$

which can be written as

$$\begin{aligned} \frac{\partial H_1}{\partial B_1} & \left[ \begin{array}{l} B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) + \\ (A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1)) \end{array} \right] = \\ & -G'(H_1) V'(P_1) - B_1 G'(H_1) V''(P_1) G(H_1) - \\ & \left( A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) \right) \frac{\partial M_1}{\partial A_1} \end{aligned}$$

or

$$\frac{\partial H_1}{\partial B_1} = \Lambda_0(B_1) + \Lambda_1 \frac{\partial M_1}{\partial A_1}$$

where

$$\begin{aligned} \Lambda_0(B_1) & \equiv \frac{-G'(H_1) V'(P_1) - B_1 G'(H_1) V''(P_1) G(H_1)}{\left[ \begin{array}{l} B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) + \\ A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) \end{array} \right]} \\ \Lambda_1 & \equiv \frac{-\left( A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) \right)}{\left[ \begin{array}{l} B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1) + \\ A_1 F''(L_1) U'(C_1) + [A_1 F'(L_1)]^2 U''(C_1) \end{array} \right]}. \end{aligned}$$

For the same reasons mentioned above, A1-A2 imply that  $\Lambda'_0(B_1) > 0$ ,  $\Lambda_0(B_1) < 0$

for  $B_1$  near zero and  $\Lambda_0(B_1) > 0$  for large  $B_1$ . Also, we will have that  $\Lambda_1 \in [-1, 0]$ .

■

**Proof of Corollary 2.**

**(Part 1 - Agricultural Shocks)** If we differentiate equation (2) with respect to  $A_1$ , we obtain

$$w^2 E [U'' (C_2)] \frac{\partial M_1}{\partial A_1} = (B_1 G'' (H_1) V' (P_1) + [B_1 G' (H_1)]^2 V'' (P_1)) \left[ -\frac{\partial L_1}{\partial A_1} - \frac{\partial M_1}{\partial A_1} \right] + E [B_2 G'' (H_2) V' (P_2) + [B_2 G' (H_2)]^2 V'' (P_2)] \left[ -\frac{\partial M_1}{\partial A_1} \right].$$

Note that because of the Envelope Theorem, we do not need to differentiate  $L_2^*$  with respect to  $A_1$ . Employing Proposition 1 and rearranging, we obtain that

$$\frac{\partial M_1}{\partial A_1} \left[ \underbrace{w^2 E [U'' (C_2)] + (\Gamma_1 + 1) \{B_1 G'' (H_1) V' (P_1) + [B_1 G' (H_1)]^2 V'' (P_1)\} + E [B_2 G'' (H_2) V' (P_2) + [B_2 G' (H_2)]^2 V'' (P_2)]}_{\equiv \Delta} \right] = -\Gamma_0 (A_1) (B_1 G'' (H_1) V' (P_1) + [B_1 G' (H_1)]^2 V'' (P_1))$$

which implies that

$$\frac{\partial M_1}{\partial A_1} = \frac{-\Gamma_0 (A_1) [B_1 G'' (H_1) V' (P_1) + [B_1 G' (H_1)]^2 V'' (P_1)]}{\Delta}.$$

Note that Proposition 1 implies that  $\Gamma_1 + 1 \in [0, 1]$  and so the denominator is unambiguously negative. Therefore, for  $A_1$  near zero, we will have that  $\Gamma_0(A_1) < 0$  and, thus,  $\frac{\partial M_1}{\partial A_1} > 0$ . In contrast, for  $A_1$  sufficiently large, we will have that  $\Gamma_0(A_1) > 0$  which implies that  $\frac{\partial M_1}{\partial A_1} < 0$ .

**(Part 2 - Home Productivity Shocks)** If we differentiate equation (2) with respect to  $B_1$ , we obtain that

$$\begin{aligned} \omega^2 [U''(C_2)] \frac{\partial M_1}{\partial B_1} = & G'(H_1) V'(P_1) + B_1 G''(H_1) V'(P_1) \frac{\partial H_1}{\partial B_1} + \\ & B_1 G'(H_1) V''(P_1) \left[ G(H_1) + B_1 G'(H_1) \frac{\partial H_1}{\partial B_1} \right] + \\ & E \left[ B_2 G''(H_2) V'(P_2) + [B_2 G'(H_2)]^2 V''(P_2) \right] \left[ -\frac{\partial M_1}{\partial B_1} \right]. \end{aligned}$$

Employing Proposition 1 and rearranging, we obtain

$$\begin{aligned} \frac{\partial M_1}{\partial B_1} \left[ \underbrace{\omega^2 [U''(C_2)] - \Lambda_1 B_1 G''(H_1) V'(P_1) - \Lambda_1 [B_1 G'(H_1)]^2 V''(P_1) +}_{\Xi} \right. \\ \left. \underbrace{E [B_2 G''(H_2) V'(P_2) + [B_2 G'(H_2)]^2 V''(P_2)]}_{\Theta} \right] = \quad (6) \\ \underbrace{G'(H_1) V'(P_1) + B_1 G'(H_1) V''(P_1) G(H_1)}_{\Theta} + \\ \Lambda_0(B_1) [B_1 G''(H_1) V'(P_1) + [B_1 G'(H_1)]^2 V''(P_1)]. \quad (7) \end{aligned}$$

However, we note that

$$\begin{aligned}\Lambda_0(B_1) &= \frac{-G'(H_1)V'(P_1) - B_1G'(H_1)V''(P_1)G(H_1)}{\underbrace{B_1G''(H_1)V'(P_1) + [B_1G'(H_1)]^2V''(P_1) + (A_1F''(L_1)U'(C_1) + [A_1F'(L_1)]^2U''(C_1))}_{\Upsilon}} \Leftrightarrow \\ -\Theta &= \Upsilon\Lambda_0(B_1) \Leftrightarrow \\ \Theta &= -\Upsilon\Lambda_0(B_1)\end{aligned}$$

and so, the RHS of equation (6) can be written as

$$\begin{aligned}\Lambda_0(B_1) [B_1G''(H_1)V'(P_1) + [B_1G'(H_1)]^2V''(P_1) - \Upsilon] = \\ -\Lambda_0(B_1) \underbrace{[A_1F''(L_1)U'(C_1) + [A_1F'(L_1)]^2U''(C_1)]}_{\Phi}.\end{aligned}$$

Hence, we obtain that

$$\frac{\partial M_1}{\partial B_1} = \frac{-\Lambda_0(B_1)\Phi}{\Xi}$$

where  $\Phi < 0$  and  $\Xi < 0$ . Therefore,  $\frac{\partial M_1}{\partial B_1} > 0$  when  $\Lambda_0(B_1) < 0$  which happens when  $B_1$  is near zero and  $\frac{\partial M_1}{\partial B_1} < 0$  when  $\Lambda_0(B_1) > 0$  which happens when  $B_1$  is large. ■

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Table 1: Summary Statistics from BASIS: Migration, Hours Worked in Household Activities, and Economic Shocks

	Definition	Mean (Standard Deviation)
Migrants <sup>1</sup>	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 <sup>1</sup>	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 <sup>1</sup>	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 <sup>1</sup>	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)
Harvest Loss <sup>2</sup>	Dummy indicating income loss due to harvest loss	0.19 (0.39)
Livestock Loss <sup>2</sup>	Dummy indicating income loss due to livestock loss	0.11 (0.31)
Quakedamage <sup>3</sup>	Cost of all household damage due to the 2001 earthquakes (in 1992 \$, in logs)	4.64 (3.80)

<sup>1</sup>Data are from 1997, 1999 and 2001. Sample size is 2008.

<sup>2</sup>Data are from 1999 and 2001. Sample size is 1365.

<sup>3</sup>Data are from 2001. Sample size is 689.

Table 2: Summary Statistics from BASIS: Hours per HH Member

	Men	Women
Field Hours (per person)	334.20 (579.61)	23.16 (154.16)
Livestock Hours (per person)	80.55 (302.87)	77.29 (247.70)
Domestic Hours (per person)	74.59 (563.41)	1422.17 (1581.29)

\*Standard deviations are reported in parentheses.  
Data are based on individual data, not HH data.

Table 3: Summary Statistics from IPUMS

	Men	Women
Hourly Wage (among everyone)	5.44 (6.45)	3.28 (8.79)
Hourly Wages (among workers)	7.50 (6.47)	6.91 (11.73)
Age	30.70 (12.29)	34.26 (15.02)
Years in the US	3.99 (5.65)	4.21 (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. Wages are in 1999\$.

Table 4: US Wage Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Male Dum	2.09 (8.40)	2.07 (8.35)	2.11 (8.54)	2.09 (8.45)	4.65 (12.19)	3.33 (9.00)
Age	0.28 (6.16)	0.22 (4.83)	0.20 (4.21)	0.20 (4.21)	0.55 (6.70)	0.35 (3.5)
Age <sup>2</sup>	-0.003 (-6.82)	-0.003 (-5.69)	-0.003 (-4.99)	-0.003 (-5.06)	-0.008 (-8.22)	-0.005 (3.33)
US Exp	-	0.30 (7.22)	0.31 (7.40)	0.33 (7.60)	0.52 (7.42)	0.82 (4.82)
US Exp <sup>2</sup>	-	-0.005 (-4.94)	-0.006 (-5.26)	-0.006 (-5.67)	-0.010 (-4.65)	-0.036 (-3.00)
Ed. Dum?	No	No	Yes	Yes	Yes	Yes
Citizen. Dum?	No	No	No	Yes	Yes	Yes
Estimator	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 5: Migratory Responses to Adverse Shocks: Male Migration

	(1) <sup>3</sup>	(2) <sup>3,4</sup>	(3)	(4)	(5)	(6)
Harvest Loss	0.31 (1.89)	-0.23 (-1.33)	0.40 (2.23)	0.40 (2.18)	0.36 (1.97)	0.34 (1.49)
Livestock Loss	0.36 (1.84)	-0.00 (-0.02)	0.29 (1.17)	0.28 (1.13)	0.31 (1.23)	0.40 (1.50)
Earthquake Damage	-0.05 (-2.15)	0.00 (0.02)	-0.01 (-0.60)	-0.01 (-0.61)	-0.00 (-0.09)	0.00 (0.16)
2001 Dummy	-0.28 (-1.55)	-0.40 (-2.05)	-0.40 (-2.22)	-0.38 (-2.09)	-0.43 (-2.27)	-0.49 (-2.32)
Demographic Variables <sup>1</sup>	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
<i>F</i> -test on Ag Shocks <sup>2</sup>	8.32 [0.016]	1.78 [0.411]	7.59 [0.023]	7.29 [0.026]	7.09 [0.029]	5.60 [0.061]
<i>F</i> -test on All Shocks <sup>2</sup>	12.18 [0.007]	1.79 [0.616]	7.83 [0.050]	7.54 [0.057]	7.09 [0.069]	5.73 [0.126]
Pseudo <i>R</i> <sup>2</sup>	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.

<sup>1</sup>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.

<sup>2</sup>*p*-values are reported below each *F*-statistic.

<sup>3</sup>In this column, the dependent variable is the sum of male and female migration.

<sup>4</sup>In this column, we employed the "counterfactual" shocks described in Section 4.

Table 6: Migratory Responses to Adverse Shocks: Female Migration

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

<sup>1</sup>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.

<sup>2</sup>*p*-values are reported below each *F*-statistic.

Table 7: Adverse Shocks and Hours Worked

	$\Delta$ Field Hours		$\Delta$ Livestock Hours		$\Delta$ Domestic Hours	
	Men	Women	Men	Women	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Harvest Loss	336.53 (2.69)	53.66 (1.22)	29.30 (0.40)	-44.63 (-0.86)	-94.78 (-1.04)	-71.01 (-0.25)
Livestock Loss	63.16 (0.41)	28.55 (0.47)	155.36 (1.96)	134.41 (2.36)	-59.90 (-0.66)	612.01 (1.90)
Earthquake Damage	13.40 (0.90)	3.27 (0.62)	9.37 (1.11)	-11.73 (-1.82)	8.38 (0.33)	153.80 (3.86)
2001 Dummy	-8.07 (-0.07)	-5.43 (-0.16)	-283.07 (-4.39)	-98.54 (-2.38)	-435.66 (-1.67)	-179.53 (-0.48)
$R^2$	0.0384	0.0207	0.0381	0.0405	0.0203	0.0644
Count-Fac Ag Shocks <sup>1</sup>	2.15 [0.120]	0.72 [0.491]	0.35 [0.707]	1.05 [0.353]	0.92 [0.402]	0.10 [0.905]
Count-Fac All Shocks <sup>1</sup>	1.44 [0.233]	0.86 [0.461]	0.49 [0.689]	1.77 [0.154]	0.61 [0.607]	1.89 [0.133]
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.

<sup>1</sup>Reports the  $F$ -test that the counter-factual shock coefficient estimates were zero. These results were obtained from separate regressions (N=1244) in which the specifications were identical to those in this table except that the actual shocks were replaced with the counter-factual shocks.  $p$ -value is in brackets.

Table 8: Robustness Check: Adverse Shocks and Hours Worked - per Capita

	$\Delta$ Field Hours		$\Delta$ Livestock Hours		$\Delta$ Domestic Hours	
	Men (1)	Women (2)	Men (3)	Women (4)	Men (5)	Women (6)
Harvest Loss	134.43 (2.07)	39.99 (1.58)	53.23 (1.19)	-47.50 (-1.15)	-52.40 (-0.78)	106.98 (0.64)
Livestock Loss	61.60 (0.76)	10.09 (0.37)	69.10 (1.32)	80.74 (1.98)	-19.80 (-0.35)	312.64 (1.64)
Earthquake Damage	1.31 (0.19)	1.15 (0.41)	5.57 (1.07)	-10.15 (-2.17)	-2.88 (-0.25)	49.42 (2.20)
2001 Dummy	12.24 (0.23)	-0.37 (-0.02)	-180.24 (-4.09)	-65.37 (-2.13)	-218.45 (-2.12)	81.87 (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.

Table 9: Robustness Check: Adverse Shocks and Hours Worked - Municipio FE

	$\Delta$ Field Hours		$\Delta$ Livestock Hours		$\Delta$ Domestic Hours	
	Men (1)	Women (2)	Men (3)	Women (4)	Men (5)	Women (6)
Harvest Loss	441.98 (2.85)	65.88 (1.29)	40.95 (0.45)	-56.27 (-0.92)	-111.36 (-0.97)	-37.01 (-0.11)
Livestock Loss	105.39 (0.58)	22.25 (0.32)	185.22 (1.92)	141.59 (2.04)	-84.42 (-0.77)	456.41 (1.19)
Earthquake Damage	5.63 (0.31)	3.20 (0.50)	11.04 (1.09)	-12.42 (-1.59)	11.20 (0.34)	174.85 (3.42)
2001 Dummy	18.87 (0.15)	-3.21 (-0.08)	-300.65 (-4.17)	-93.10 (-1.97)	-448.14 (-1.47)	-275.61 (-0.65)
$R^2$	0.1029	0.1091	0.1398	0.0925	0.0348	0.1344
Households	1265	1265	1265	1265	1265	1265

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

Figure 1

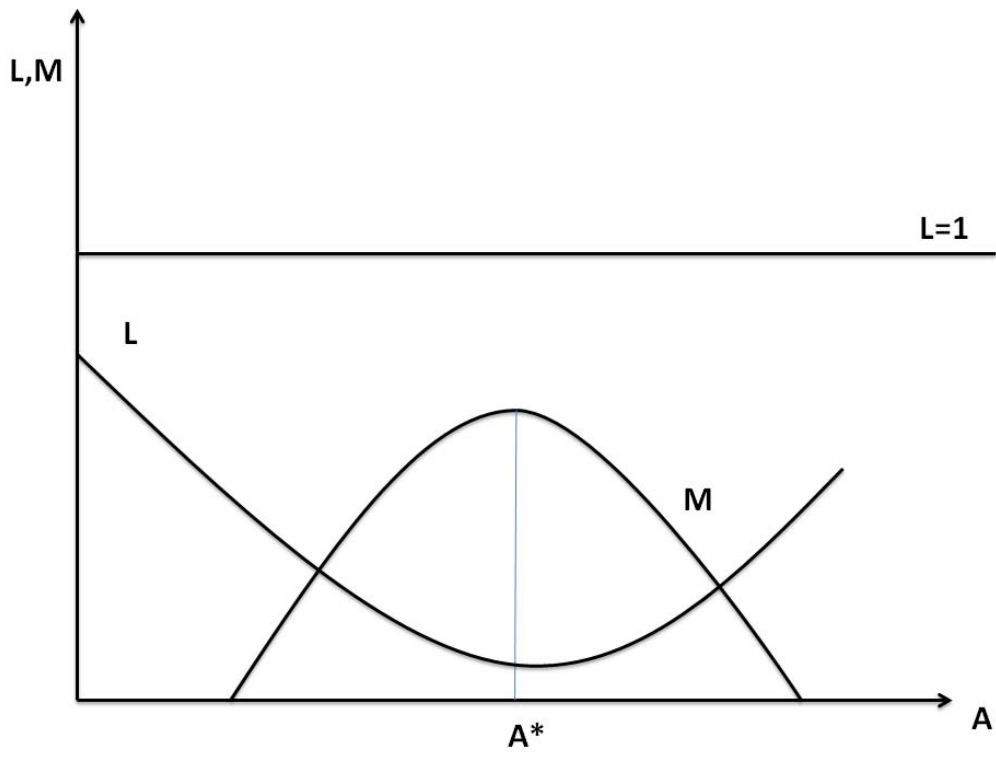


Figure 2

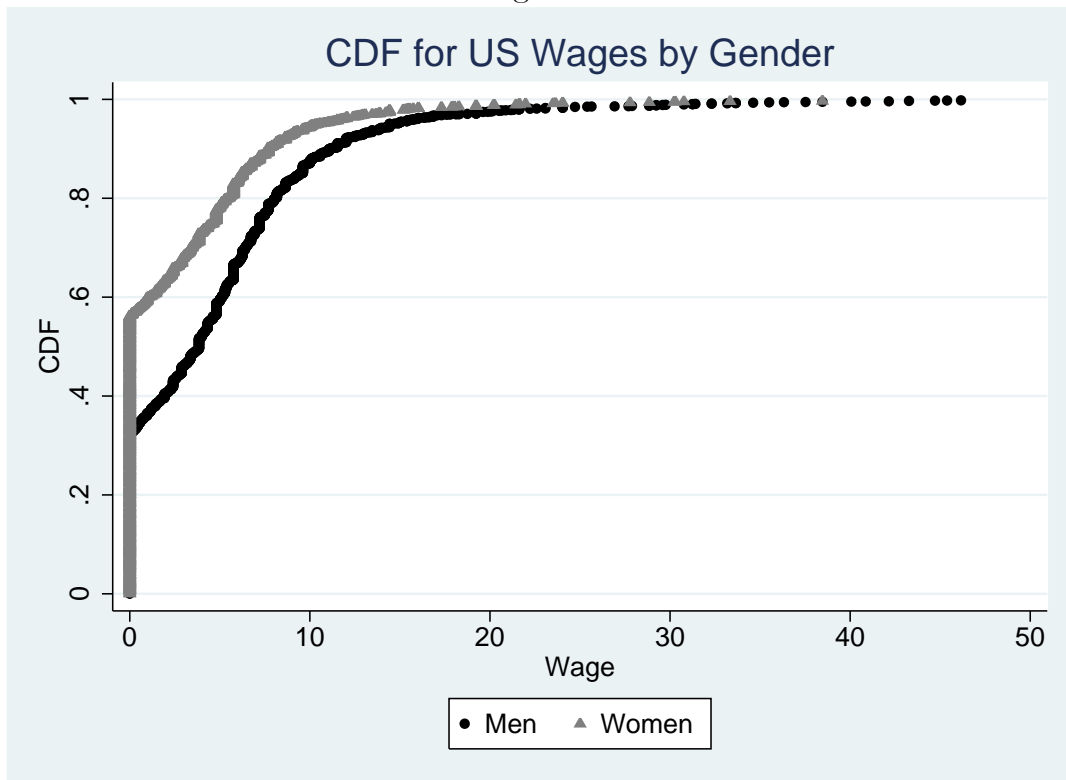


Figure 3

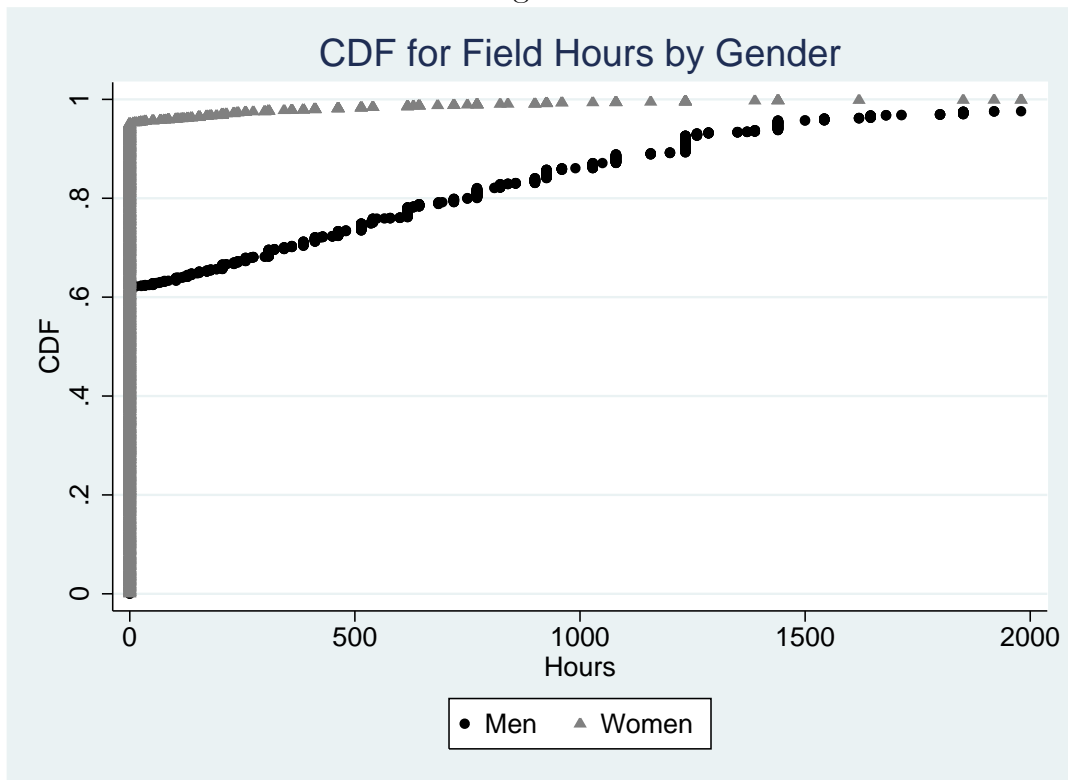


Figure 4

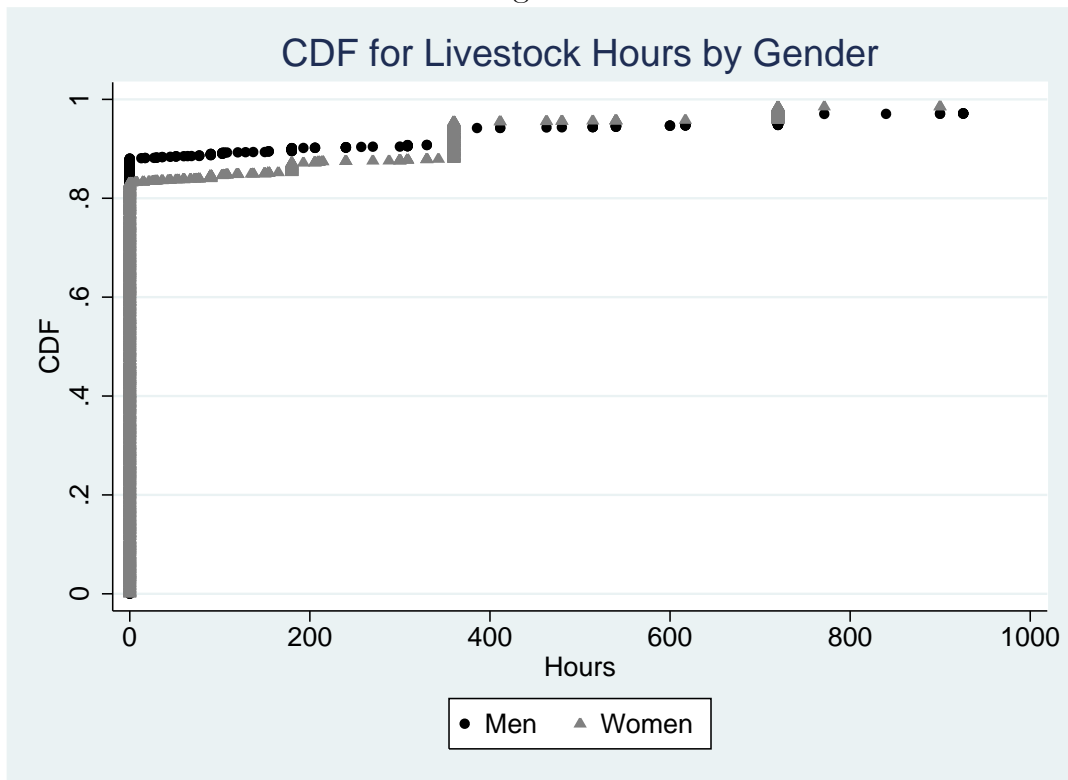


Figure 5

