Household Labor Allocation in Remittance-Receiving Households:

The Case of El Salvador

June 2009

Draft – Please Do Not Cite

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1. Introduction

Between 1980 and 1992, El Salvador's civil war claimed the lives of over 80,000 people. Massive flows of refugees, escaping the conflict, contributed to a Salvadoran diaspora and to a culture of migration that remains today. A conservative estimate based on U.S. census data indicates that over 800,000 Salvadorans, equivalent to 12% of the in country Salvadoran population, currently live in the United States and send money, known as remittances, back to family members in El Salvador (DIGESTyC, 2006) [1]. Remittances have surpassed official development assistance, foreign direct investment, and tourism to become the largest source of foreign exchange for El Salvador. In 2006, El Salvador received $US3 billion in remittances, representing more than 20 percent of its gross domestic product (GDP), making El Salvador the second highest per capita recipient of remittances[2] in all of Latin America and the Caribbean (Salvadoran Central Bank, 2006).

The physical separation of migrants from their Salvadoran household distinguishes these migrants from a typical household wage earner. Remittances are therefore considered a form of non-wage income for the receiving household. If one assumes leisure to be a normal good, in the simplest case, one would expect an increase in non-wage income from any source to lead to a decrease in household labor supply. However, in the case of remittances, this relationship may be complicated by (1) incomplete labor markets, which may prevent hiring non-household labor to substitute for migrated labor; (2) imperfect substitutability between family labor and wage labor; (3) the lag between migration and remittance flows; (4) post-migration family composition

[1] Other estimates suggest that there are between 1.5 and 2.5 million Salvadorans living in the United States many of whom arrived without legal documentation. This could represent up to 30 percent of the Salvadoran population. The population of El Salvador was 6.9 million people in 2006.

[2] Panama receives the highest remittances per capita in the Latin America and Caribbean region.

effects on farm production activities and on farm labor requirements; and (5) migrant remittances that act as a substitute for missing credit and insurance markets, as suggested by the New Economics of Labor Migration developed by Stark (1991), which may induce agricultural investment. Agricultural investment increases the marginal product of on-farm labor and provides incentives for family members to reallocate more of their labor to the farm. The relationship between remittances and household labor supply, given these considerations, is complex.

This paper examines the impact that remittances and migration have on the remittance-receiving households' labor supply decisions, specifically examining how they affect off-farm agricultural work, on-farm work, household work, and non-agricultural self-employment work for adult males, adult females, and children in a household. This paper fills a gap in the literature by focusing on a range of labor allocations for different family members in agricultural households. The few previous studies in this area have used cross-sectional data to explore the relationships between migration, remittances, and labor outcomes. This study contributes to this literature using four rounds of panel data collected over six years from 451 agricultural households in El Salvador to estimated the impact of migration and remittances on household members' labor allocations.

Section 2 discusses previous research in this area and Section 3 presents an agricultural household model taking into account credit constraints, migration and remittances. Section 4 discusses data used for the empirical analysis. Section 5 presents the empirical models and approach, section 6 discusses the empirical results, and section 7 offers some concluding comments.

2. Previous Research

The NELM developed by Stark (1991) departs from earlier theories of migration in two ways. First, it views migration not as a result of individual optimizing behavior, but rather as the rational behavior of a group, such as a family. Within the collective optimization of household welfare, consequences of migration such as remittances are incorporated into the migration decision, not simply accidental byproducts. Second, the NELM posits that migration is a function of missing (or underdeveloped) markets, specifically credit, insurance, and capital markets. This paper focuses on these two elements of the NELM, examining family labor allocation decisions in the face of a credit constraint that can be relieved through migration and remittances[3].

The relationship between remittances and household labor supply has rarely been studied in the economics literature until recently. Funkhouser (1992) was the first to examine the connection between household labor supply and remittances. He used a probit model to estimate the probability of wage labor force participation as well as self-employment of non-migrant males and females in Nicaragua. Funkhouser finds that the effect of remittances on wage labor participation is negative, but the effect of remittances on the probability of self-employment is positive.

A recent paper by Acosta (2006) also examines the relationship between labor supply and remittances, using data from El Salvador. He uses a nationally representative, cross-sectional household survey in El Salvador and finds that robust estimates, corrected for selection bias, differ from previous estimates. Specifically, his estimates suggest that receiving remittances decreases adult female labor supply, but not adult male labor supply. He also finds, consistent

[3] Stark also contends that migration is not simply a response to labor market wage differentials. Rather, he suggests, people assess their relative wealth within a given reference group and are induced to migrate if they are relatively worse off than their peers. This theory, known as the relative deprivation theory, implies that relative deprivation and income uncertainty will be important factors in the decision to migrate (Stark 1984, Stark & Taylor 1991, Stark 1991). Relative deprivation theory is not examined or considered in this paper.

with Funkhouser, that middle-aged males who receive remittances are more likely to engage in self-employment. Funkhouser explains this phenomenon by suggesting that an increase in non-wage income decreases labor force participation in general, but if capital constraints are present an increase in non-wage income increases the opportunity for self-employment because it relieves capital constraints by substituting for missing credit markets.

In the Philippines, Rodriguez and Tiongson (2001) find that having a migrant reduces the income earned in the local labor market by non-migrant relatives. Migration causes a reduction in both labor market participation as well as the number of hours worked. They posit that migration causes non-migrants to substitute income for more leisure. However, they find that more educated non-migrants are less likely to pull out of the labor force when a family member migrates. The authors recognize that their estimates are likely biased by simultaneity, measurement error, and heterogeneity, which are not corrected for in their regressions.

Amuedo-Dorantes and Pozo (2006) use the National Household Survey of Income and Expenditures in Mexico for 2002 to estimate the impact of remittances on the employment status of, and hours worked by, both men and women. They investigate whether male and female labor is supplied differently across different types of employment (agricultural, non-agricultural, etc.) in rural versus urban areas. This study finds that male labor force participation does not change as a result of remittances, however their type of employment does. Increases in remittance flows lead to decreased formal labor market participation and increased participation in the informal sector. Female labor force participation decreases as a result of receiving remittances in rural areas[4].

[4] Since this dataset specifically samples rural households, no conclusion can be drawn regarding labor force decisions or participation in urban areas.

These few studies on the impact of migration and remittances on household labor allocations provide evidence that women decrease their overall labor supply, while men do not, although men increase their labor supply in the informal sector or in self-employment activities. There is not, however, an adequate understanding of what happens to agricultural labor either on-farm or off-farm, nor does the literature examine the response of child labor to migration and remittances. A number of empirical issues were raised in these papers which are addressed in this study. Most importantly, migration and remittances are likely to be jointly determined with household labor supply. An instrumental variable (IV) approach, using community level migration and remittance related variables as instruments, has been suggested in the literature as a solution to this problem. Specifically, this study builds on and contributes to this literature by providing a wider understanding of labor supply decisions in rural households that have migrants and receive remittances.

3. Theoretical Model

The objective of this model is to study the impact of migration and remittances on the allocation of household labor. To consider this relationship, a two-period agricultural household model is presented, including two individuals, an adult male and an adult female[5]. In this model we assume that the adult male migrates and remains in the migrant destination for both periods. This is a reasonable assumption since a majority of the migrants are male. Therefore, only an adult female remains in the household[6]. This two-period model is employed primarily to capture

[5] Children are excluded as a simplifying assumption. The response of children's labor supply may be complicated by remittances enabling them to attend school (see Cox-Edwards and Ureta, 2003 for estimates of the impact of remittances and migration on schooling outcomes.

[6] In the empirical section, this assumption is relaxed and it is possible to have a migrant male as well as adult males that remain in the household, whereas the theoretical model assumes there is only one adult male in the household that migrates.

the impact of both migration and remittances in the first period on labor outcomes, focusing on migration and remittances' role in helping the household to overcome credit constraints and thereby invest in agricultural capital. Four cases of an agricultural household model are considered: (1) no migrants and no credit constraints; (2) no migrants and a credit constraint; (3) a migrant and no credit constraint; and (4) a credit constrained household that receives remittances.

Case 1: A household with no migrants and no credit constraints

Consider a standard utility maximization problem, where household members jointly choose their consumption in both periods (C_t^i), where t=1,2 for time periods 1 and 2 and $i = M,F$ for male and female household members, as well as their allocation of their total time endowment (T_t^i). Each member's total time endowment is divided between market work (M_t^i), and on-farm work[7] (R_t^i). Given $\{r, w_t, \beta, K_0\}$, where r is the interest rate, w_t is the wage rate for family off-farm work as well as the price of hired labor, β is a discount factor that satisfies $1>\beta>0$, and K_0 is the initial endowment of capital, $\overline{G}$ is a fixed stock of agricultural land, the household chooses $\{C_t^i, R_t^i, M_t^i, B, K_t\}_{t=1}^{2}$ to jointly maximizes a two period utility function, B is borrowing which is borrowed in period 1 and paid back in full in period 2, and K_t is capital (land area is assumed to be fixed as a simplifying assumption). To simplify the model, the possibility of hired labor is excluded and it is assumed that since this household is selling their labor in the market, there is no hired on-farm labor. Additionally, leisure is also excluded from the model as a simplifying assumption. The utility function is assumed to be additively separable,

[7] On-farm work, in the theoretical model, includes home production.

continuously differentiable, monotonically increasing, and strictly concave in all of its arguments such that $U^{'}_{C^i_t} > 0$ and $U^{''}_{C^i_t C^i_t} < 0$:

$$Max \quad U^M(C_1^M;Z)+U^F(C_1^F;Z)+\beta[U^M(C_2^M;Z)+U^F(C_2^F;Z)] \qquad (1)$$

where Z is a vector of time invariant household specific characteristics that affect idiosyncratic household preferences. In this model, a period can be thought of as a long time period, such as 10 years, to allow for borrowing and investing in the same time period. The time structure is appropriate when talking about migration since migrants often leave for significant periods of time and often return upon retirement. When a household is *not* credit constrained they maximize (1) subject to the following budget constraints for time periods 1 and 2 and M and F:

$$C_1^F + rK_1 = f\,(R_1^F, K_0 + K_1, \overline{G}) + w_1 M_1^F + B \qquad (2)$$

$$C_2^F + rK_2 + (1+r)B = f\,(R_2^F, K_0 + K_1 + K_2, \overline{G}) + w_2 M_2^F \qquad (3)$$

$$C_1^M + rK_1 = f\,(R_1^M, K_0 + K_1, \overline{G}) + w_1 M_1^M + B \qquad (4)$$

$$C_2^M + rK_2 + (1+r)B = f\,(R_2^M, K_0 + K_1 + K_2, \overline{G}) + w_2 M_2^M \qquad (5)$$

and time constraints for periods 1 and 2 for M and F:

$$T_1^F = R_1^F + M_1^F \qquad (6)$$

$$T_2^F = R_2^F + M_2^F \qquad (7)$$

$$T_1^M = R_1^M + M_1^M \qquad (8)$$

$$T_2^M = R_2^M + M_2^M \qquad (9)$$

Income for each agricultural household is the value of their agricultural output, as determined by an agricultural production function in each time period *f(.)*, total family wage income. The production and consumption decisions in this case are separable, given that perfect credit markets are assumed, such that the household will first maximize agricultural profits and

then consider the solution to this problem in their consumption decision. The price of the consumption good in both periods is normalized to 1 and set equal to the price of the agricultural output. The agricultural production function is assumed to be strictly concave and increasing in its argument of on-farm labor (R_t) and capital (K_t). A household buys capital in period 1 and supplements the initial endowment of K_0 with purchased K_1 in the same time period. Capital purchased in the second time period, K_2, supplements existing K from the previous time period. This model assumed that there is no depreciation of K between periods. The Lagrangian equation and its first order conditions (FOCs) are as follows:

$$\mathcal{L} = U^M(C_1^M;Z)+U^F(C_1^F;Z)+\beta[U^M(C_2^M,;Z)+U^F(C_2^F;Z)] -$$

$$\lambda_1\ (C_1^F+rK_1-\{f\ (R_1^F,K_0+K_1,\overline{G})+w_1M_1^F+B\}) -$$

$$\lambda_2\ (C_2^F+rK_2+(1+r)B-\{f\ (R_2^F,K_0+K_1+K_2,\overline{G})+w_2M_2^F\}) -$$

$$\lambda_3(C_1^M+rK_1-\{f\ (R_1^M,K_0+K_1,\overline{G})+w_1M_1^M+B\}) -$$

$$\lambda_4(C_2^M+rK_2+(1+r)B-\{f\ (R_2^M,K_0+K_1+K_2,\overline{G})+w_2M_2^M\})+$$

$$\mu_1(T_1^F-R_1^F-M_1^F)+\mu_2(T_2^F-R_2^F-M_2^F)+\mu_3(T_1^M-R_1^M-M_1^M)$$

$$+\mu_4(T_2^M-R_2^M-M_2^M) \qquad (10)$$

The first order conditions for this problem are:

$$U'_{C_1^i}=\beta(1+r)U'_{C_2^i} \qquad (11)$$

$$f'_{R_t^i}=w_t \qquad (12)$$

$$f'_{k_t}=r \qquad (13)$$

as well as budget and time constraints (2) – (9).

Assuming complete and functioning labor markets that are free of transactions costs, from these first order conditions we find that the off-farm wage rate equals the marginal product of labor on-farm such that $w_t = f'_{R_t^i}$. On-farm labor supply is determined by $f'_{R_t^i} = w_t$. Investment in capital for agricultural production happens unconstrained in period 1 and is paid back in period 2. Given that this household is not credit constrained the household achieves optimal investment and the marginal product of *K* is equal to the exogenous rental rate of K, $f'_{K_1} = r$ and $f'_{K_2} = r$.

The solution to this household maximization problem is a set of Marshallian labor supply functions in the form:

$$R_t^{i*} = R_t(w_1, w_2, r, \delta, K_0, \overline{G}) \quad (14)$$

$$M_t^{i*} = M_t(w_1, w_2, r, \delta, K_0, \overline{G}) \quad (15)$$

$$H_t^* = H_t(w_1, w_2, r, \delta, K_0, \overline{G}) \quad (16)$$

and an optimal level of K is determined by:

$$K_1^* = K_1(w_1, w_2, r, \delta, K_0, \overline{G}) \quad (17)$$

Case 2: No migration but a credit constraint is present.

Consider the case of a household with no migrants, but one that faces a credit constraint. In this case a household will maximize the same household utility as given in (1) subject to constraints (2) – (9) but will now do so under an addition credit constraint in the form:

$$B_1 \leq \overline{B_1} \quad (18)$$

If credit constrained, the household faces an upper bound on borrowing represented as $\overline{B_1}$. A household can choose to invest in *K* in the first period. If the credit constraint (18) is binding then the asset stock will be below its optimal level and there will be a shadow interest rate.

Assuming that the credit constraint is binding, the investment and consumption decisions at the household level are no longer separable. The unconstrained household's first order conditions imply that $\frac{U'_{c_1^i}}{\beta U'_{c_2^i}} = 1 + r$. In the constrained case, this relationship is $\frac{U'_{c_1^i}}{\beta U'_{c_2^i}} = 1 + r^*$, where r* is the shadow value of capital and r*>r if the credit constraint is binding.

The Marshallian labor supply functions are now:

$$R_t^{i*} = R(w_1, w_2, r^*(.), \delta, \overline{G}, K_0) \quad (19)$$

$$M_t^{i*} = M(w_1, w_2, r^*(.), \delta, \overline{G}, K_0) \quad (20)$$

$$H_t^* = H_t(w_1, w_2, r^*(.), \delta, \overline{G}, K_0) \quad (21)$$

and the optimal level of *K* is determined by:

$$K_1^* = K_1(w_1, w_2, r^*(.), \delta, \overline{G}, K_0) \quad (22)$$

where $r^* = r(w_1, w_2, \overline{B}, \overline{G}, K_0, \delta)$. Comparing the case 1 and case 2, if we assume the credit constraint is binding in case 2, we would hypothesize that R^* in (19) will be less than R^* in (14). Since the credit constraint is binding, producers are unable to optimally invest in agricultural assets, causing f_K in the unconstrained case to be greater than f_K in the constrained case, all other factors being equal. Case 1 and Case 2 are base models and are presented for completeness, given that the data used in this analysis represents both migrant and non-migrant households. The next two models incorporate migration and remittances into the above two models.

Case 3: A household with migrants and no credit constraints.

The objective of the model presented in this case is to introduce migration and remittances into a standard model of an agricultural household. It is assumed that the migration decision has already taken place. (The migration decision occurs through a comparison of indirect utility with and without migration and will be modeled later in this section.) If a household has a migrant, then the migrant can send remittances to the non-migrant. The level of remittances is a function of the migrant's wage in the destination city and the probability of employment.

Consider again a standard utility maximization problem, where household members jointly choose C_t^i in both periods and choose the allocation of T_t^F. Each household member's time endowment is divided again into M_t and R_t. A migrant's time endowment in time period *t* is (T_t^M), assuming the migrant is the male household member. Given {*r*, w_t, w_{us}, N_{us}, β, $K_0, \overline{G}$ }, w_{us} is the migrant's wage rate in the destination U.S. city, N_{usa} is the unemployment rate in the destination U.S. city, the household chooses $\{ C_t^i, R_t, M_t, B, K_t \}$. The utility function is assumed to be additively separable, continuously differentiable, increasing, and concave in all of its arguments as above such that a household will:

$$\underset{\{ C_t^i, R_t, M_t, K_t, B \}}{Max} \; U^M(C_1^M; Z) + U^F(C_1^F; Z) + \beta[U^M(C_2^M; Z) + U^F(C_2^F; Z)] \tag{23}$$

subject to the following consumption constraints:

$$C_1^F + rK_1 = f(R_1^F, K_0 + K_1, \overline{G}) + w_1 M_1^F + B + w_{usa}(1-N)T_1^M - C_1^M \tag{24}$$

$$C_2^F + rK_2 + (1+r)B = f(R_2^F, K_0 + K_1 + K_2, \overline{G}) + w_2 M_2^F + w_{usa}(1-N)T_2^M - C_2^M \tag{25}$$

Time constraints for the female (non-migrant) periods 1 and 2 are:

$$T_1^F = R_1^F + M_1^F \tag{26}$$

$$T_2^F = R_2^F + M_2^F \tag{27}$$

For simplicity the migrant's total time allocation T_t^M is split between a fixed level of leisure and the rest of his time is spent in the labor force, either working or looking for work. The migrant's labor force time therefore is not a choice variable. Further, since remittances are determined by total income of the migrant minus consumption, they are substituted out to obtain the full household budget constraint as shown in (24) and (25).

Assuming complete and functioning labor markets that are free of transactions costs, first order conditions (FOCs) for the maximization problem are[8]:

$$U'_{C_t^M} = U'_{C_t^F} \qquad t=1,2 \tag{28}$$

$$U'_{C_1^F} = \beta(1+r)U'_{C_2^F} \tag{29}$$

$$f'_{R_t} = w_t \qquad t=1,2 \tag{30}$$

$$(2+r)\,f'_{k_1} = r(1+r) \tag{31}$$

$$f'_{k_2} = r \tag{32}$$

as well as constraints (24) – (27). These FOCs imply that the off-farm wage rate equals the marginal product of labor on-farm such that $w = f'_{R_t}$. On-farm labor supply is determined by $f'_{R_t} = w_t$. Since this household is not credit constrained we assume that the household achieves optimal investment and the marginal product of *K* is equal to an exogenous rental rate of *K* in period 2, $f'_{K_2} = r$ and $(2+r)\,f'_{k_1} = r(1+r)$ in period one, which is a discounted rental rate of

[8] See appendix 1 for the complete set first order conditions before substituting out Lagrange multipliers.

capital. This model exhibits a separability property that allows production and investment decisions to be made to maximize life-cycle wealth without regard to consumption decisions. This property breaks down in cases 2 and 4, where a credit constraint is introduced into the model.

Still, assuming no credit constraint, an increase in US wages shifts the budget constraint allowing the Salvadoran household to consume more. When the male migrates, a household gives up a working member and sends him to a migrant destination labor market, so he can no longer contribute to any type of household labor. In the model above it is assumed that the household provides all household labor and sells some labor. For parsimony, the option of hired labor is excluded. Given the constraints (24) - (27), and solving for optimal levels of *R, M, H,* and *K*, the Marshallian household labor supply functions are:

$$R_t^{F*} = R_t(w_1, w_2, r, \beta, K_0, \overline{G}, J(.)) \tag{33}$$

$$M_t^{F*} = M_t(w_1, w_2, r, \beta, K_0, \overline{G}, J(.)) \tag{34}$$

$$H_t^* = H_t(w_1, w_2, r, \beta, K_0, \overline{G}, J(.)) \tag{35}$$

and an optimal level of K is determined by:

$$K_1^* = K_1(w_1, w_2, r, \beta, K_0, \overline{G}) \tag{36}$$

Given that the second order sufficient conditions are satisfied, namely a positive bordered Hessian exists which implies strict convexity of the indifference curve at the point of tangency, the comparative static properties of the model are examined to determine the theoretical signs of the relationship between wage rates in the United States and the choice variables in this model. By totally differentiated first order conditions, (28) – (34), and constraints, (24) - (27), a linear system emerges:

$$U_{C_1^M C_1^M} dC_1^M - U_{C_1^F C_1^F} dC_1^F = 0 \tag{37}$$

$$\beta\, U_{C_2^M C_2^M} dC_2^M - \beta U_{C_2^F C_2^F} dC_2^F = 0 \tag{38}$$

$$f_{R_1 R_1} dR_1 + f_{R_1 K_1} dK_1 = 0 \tag{39}$$

$$f_{R_2 R_2} dR_2 + f_{R_2 K_2} dK_2 + f_{R_2 K_1} dK_1 = 0 \tag{40}$$

$$f_{K_1 K_1} dK_1 (1+r) + f_{R_1 K_1} dR_1 (1+r) + f_{K_1 K_1} dK_1 + f_{K_1 R_1} dR_1 = 0 \tag{41}$$

$$f_{K_2 K_2} dK_2 + f_{R_2 K_2} dR_2 + f_{K_2 K_1} dK_1 = 0 \tag{42}$$

$$U_{C_1^F C_1^F} dC_1^F - \beta U_{C_2^F C_2^F} dC_2^F (1+r) = 0 \tag{43}$$

$$f_{R_1} dR_1 + f_{K_1} dK_1 + w_1 dM + dB - dC_1^F - r dK_1 + dw_{us}(1-N)T_1 - dC_1^M = 0 \tag{44}$$

$$\begin{aligned} &f_{R_2} dR_2 + f_{K_1} dK_1 + f_{K_2} dK_2 + w_2 dM_2 - dC_2^F \\ &- r dK_2 - (1+r) dB + dw_{us}(1-N)T_2^M - dC_2^M = 0 \end{aligned} \tag{45}$$

$$T_1^F - dR_1 - dM_1 = 0 \tag{46}$$

$$T_2^F - dR_2 - dM_2 = 0 \tag{47}$$

Forming a matrix of the partials in equations (37) - (47) , dividing through by dw_{usa}, and using Cramer's rule to solve for changes in the choice variables $\{ C_t^i, R_t^i, M_t^i, B, K_t \}$ the following relationships result:

$$\frac{dC_1^M}{dw_{us}} = \frac{-\beta(2U_{C_2^F C_2^F} + U_{C_2^F C_2^F} U_{C_2^M C_2^M} U_{C_1^F C_1^F}(1+r)}{A}$$

$$\frac{+U_{C_2^F C_2^F} U_{C_1^F C_1^F} U_{C_2^M C_2^M} [r^2 T_1^M (1-N) + (2+r) T_2^M])}{A} \tag{48}$$

where $A = -U_{C_2^M C_2^M}[(2+r)U_{C_1^F C_1^F} U_{C_1^M C_1^M} + \beta(1+r)\{U_{C_1^F C_1^F} U_{C_2^F C_2^F} + U_{C_1^M C_1^M} U_{C_2^F C_2^F}\}]$.

Given the convexity properties of *U*, specifically $U_{C_t^i C_t^i} < 0$ and fact that *T*, β, and *r* are all positive and the condition *0<N<1*, it is clear that A > 0 and further the expression in the

numerator is positive, and as a result $\frac{dC_1^M}{dw_{us}} > 0$. This result is intuitively appealing since we would expect the migrant's consumption to increase as his wage in the US increases. We would expect that consumption variables for both household members in all time periods to increase with an increase in w_{us} and indeed comparative static results support this a priori expectation as shown here:

$$\frac{dC_1^F}{dw_{us}} = \frac{-\beta(1+r)U_{C_2^F C_2^F}U_{C_1^M C_1^M}U_{C_2^M C_2^M}[(T_1^M(1-N)(1+3r+r^2)+T_2^M(1-N)(2+r)]}{A} \quad (49)$$

$$\frac{dC_2^M}{dw_{us}} = \frac{-U_{C_2^F C_2^F}U_{C_1^M C_1^M}U_{C_1^F C_1^F}[(T_1^M(1-N)(2+3r+r^2)+T_2^M(1-N)(2+r)]}{A} \quad (50)$$

$$\frac{dC_2^F}{dw_{us}} = \frac{-U_{C_2^M C_2^M}U_{C_1^M C_1^M}U_{C_1^F C_1^F}[(T_1^M(1-N)(2+3r+r^2)+T_2^M(1-N)(2+r)]}{A} \quad (51)$$

Separability implies that an increase in income from remittances or any other source should have no affect on production variables if markets are functioning properly. Comparative static results, consistent with expectations, support separability such that $\frac{dR_t}{dw_{us}} = 0, \frac{dK_t}{dw_{us}} = 0,$ and $\frac{dM_t}{dw_{us}} = 0$. Additionally, given that remittances are the only connection between C_t^F and w_{us} and we know from (49) and (51) that an increase in w_{us} increases C_t^F, it follows that as wages in the US increase, remittances must increase to facilitate the increase in C_t^F.

In the case of borrowing, the relationship can be determined by:

$$\frac{dB}{dw_{us}} = \frac{(2+r)T_1U_{C_1^F C_1^F}U_{C_1^M C_1^M} - T_2\beta(1+r)(2+r)(U_{C_2^F C_2^F}U_{C_1^F C_1^F} - U_{C_2^F C_2^F}U_{C_1^M C_1^M})]}{A} \quad (52)$$

The sign of $\frac{dB}{dw_{us}}$ is ambiguous. The first and third terms in the numerator of the expression is positive, however the second term is negative, and therefore the sign of the total expression depends on the relative magnitude of the terms.

In sum, comparative statics show that an increase in US wages will increase consumption for all agents in all time periods, and will have no effect on household labor allocation decisions in El Salvador, assuming that separability holds. Further, the relationship between borrowing and w_{us} is ambiguous and depends on the relative magnitudes of the relevant terms in (52). Note that in this case total production and total use of labor on-farm are unaffected by credit constraints.

Case 4: A household with migrants and a credit constraint.

In case 3 the relationship between wages and consumption were investigated and it was shown that consumption increases when wages in the US increase, and since the only income linkage between the migrant and the household is remittances, we conclude that remittances increase when wages in the US increase. This conclusion about the relationship between wages and remittances is used in case 4, where a household credit constraint is introduced. The household's income in case 4 increases from remittances sent, J_t. The migrant's wage and consumption decisions are excluded from this model to make the comparative static analytics tractable. Given the credit constraint, it is expected that separability will break down and the exogenous income shock will affect household labor allocations and capital investments.

The household will again maximize the same two period utility (23), as in the third case, subject to consumption and time constraints in each period as well as a credit constraint:

$$C_1 + rK_1 = f\,(R_1, K_0 + K_1, \overline{G}) + w_1 M_1 + \overline{B}_1 + J_1 \tag{53}$$

$$C_2 + rK_2 + (1+r)\overline{B}_1 = f\,(R_2, K_0 + K_1 + K_2, \overline{G}) - w_2 M_2 + J_2 \tag{54}$$

$$B_1 = \overline{B_1} \tag{55}$$

$$T_1^F = R_1^F + M_1^F \tag{56}$$

$$T_2^F = R_2^F + M_2^F \tag{57}$$

If the credit constraint is binding a household will not achieve optimal investment in agricultural assets. Remittances, however, can relieve the credit constraint, allowing the household to invest in *K* and change the household labor allocation. First order conditions for the utility maximization problem in case 4 are:

$$U_{C_1} - U_{C_2}(1+r) = \rho \tag{58}$$

$$f'_{R_t} = w_t \qquad t=1,2 \tag{59}$$

$$f'_{k_2} = r \tag{60}$$

$$U_{C_1}(f_{K_1} - r) + U_{C_2} f_{K_1} = 0 \tag{61}$$

as well as constraints (53) – (57), where ρ is the Lagrangian multiplier associated with the credit constraint, and also is the shadow value of credit (referred to previously as *r*).*

Again, given that the second order sufficient conditions discussed above are satisfied, by total differentiating the first order conditions, a matrix of partials is formed from the linear system of totally differentiated first order conditions. The comparative static results are examined to reveal the direction that the choice variables change with a change, in this case, of *J*. The variable *J* represents the exogenous positive income shock. The determinant labeled *A*, of the matrix of partials resulting from the total differentiation of the FOC is:

$$A = (U_{C_1} + 1)[\sigma_1\sigma_2] + U_{C_1C_1}(f_{k_1} - r)[f_{R_1K_1} f_{R_1R_1}\sigma_2] - U_{C_1C_1}(f_{k_1} - r)(f_{k_1R_1} - r) f_{R_1R_1}\sigma_2$$

$$-U_{C_2C}[f_{R_1K_1} f_{R_1R_1}\sigma_2] + U_{C_2C_2}(f_{K_2R_2} - r)[f_{R_1R_1} f_{K_2R_2} f_{R_2K_1} - f_{K_2K_1} f_{R_1R_1} f_{R_2R_2}]$$

$$-U_{C_1C_1}(f_{K_1} - r)w_1 f_{R_2K_1}\sigma_2 + U_{C_2C_2}w_2[f_{K_2K_2} f_{R_1R_1} f_{R_2K_1} - f_{K_2K_1} f_{R_2K_2} f_{R_1R_1}] \qquad (62)$$

where $\sigma_t = f_{K_tR_t}{}^2 - f_{R_tR_t} f_{K_tK_t}$, *t = 1,2.* The production function is concave, and from the convexity properties of the convex production set we know that for convexity to hold, $f_{K_tR_t}{}^2 < f_{R_tR_t} f_{K_tK_t}$, $f_{K_t} > 0$, $f_{R_t} > 0$, $f_{M_t} > 0$, $f_{R_tR_t} < 0$, $f_{K_tK_t} < 0$, *and* $f_{K_tR_t} > 0$.

There are several terms whose sign cannot be determined using the convexity properties alone. For more information about signs on components of A, the Hessian matrix, formed by the second order conditions of the objective function, is examined. Specifically, for the objective function to be at a maximum, its associated Hessian matrix must be negative definite. The second order sufficient conditions that ensure the objective function is at a maximum are determined by evaluating the principal minors of the Hessian matrix. In this case for the Hessian to be negative definite it must hold that $f_{R_1R_1} f_{K_2R_2} f_{R_2K_1} - f_{K_2K_1} f_{R_1R_1} f_{R_2R_2} > 0$.

Additionally, if a household is credit constrained, it is assumed that $r > f_{K_1}$ and $r > f_{K_2R_2}$. Lastly, it must also be assumed that $f_{R_1R_1} f_{K_1R_2} f_{K_2K_2} - f_{K_2K_1} f_{R_2K_2} f_{R_1R_1} > 0$ as a property of the production technology. Using these relationships and the convexity properties of *U* discussed above, the sign of A is positive.

Given that the relationship of interest here is the change in household choice variables change with a change in *J, dJ* is divided through and again Cramer's rule is applied to the matrix of second order conditions to determine the relationship between the household's choice variables and an increase in *J*. The relationship between consumption and an increase in income is positive as shown by:

$$\frac{dC_1}{dJ} = \{(U_{C_1}+1)[\sigma_1\sigma_2] - U_{C_1C_1}[f_{R_1K_1} f_{R_1R_1}\sigma_2 + f_{R_2K_2}{}^2 f_{R_1R_1} f_{R_2K_1} - f_{R_2K_2} f_{R_1R_1} f_{K_2K_1} f_{R_2R_2}]$$

$$+(f_{K_2R_2}-r)[f_{R_1R_1} f_{K_2R_2} f_{R_2K_1} + f_{K_2K_1} f_{R_1R_1} f_{R_2R_2}] + (f_{K_1R_1}-r)[\sigma_2 f_{R_1R_1}] + U_{C_2C_2} w_1[\sigma_2 f_{R_1K_1}]$$

$$U_{C_2C_2} w_2[f_{K_2K_2} f_{R_1R_1} f_{R_2K_1} - f_{K_2K_1} f_{R_2K_2} f_{R_1R_1}]\ \}/\ \mathrm{A} \qquad (63)$$

Using the same convexity properties, (63) is positive if $f_{R_2K_2} f_{R_1R_1} f_{R_2K_1} > f_{K_2K_1} f_{R_1R_1} f_{R_2R_2}$ and $f_{K_2K_2} f_{R_1R_1} f_{R_2K_1} > f_{K_2K_1} f_{R_1R_1} f_{R_2K_2}$. This result is consistent with expectations since we would expect that an increase in income would result in an increase in consumption as it did in case 3, and that the introduction of a credit constraint should not change the direction of this relationship.

Comparative static results confirm that separability breaks down when a household faces a credit constraint. The most basic evidence of the failure of separability is that there is a non-zero effect of *J* on household farm labor, off-farm labor, and capital investment. This is in contrast with results from case 3, where separability held, which indicated that the US wage rate (and by extension J) had no effect on production side variables. The relationship between on-farm family labor and *J* is:

$$\frac{dR_1}{dJ} = \frac{-(f_{K_1}-r)(U_{C_1C_1} f_{R_1R_1} - U_{C_2C_2} f_{R_2R_2})\sigma_2}{A} \qquad (64)$$

The sign of $\frac{dR}{dJ}$ is positive. A positive sign suggests that an increase in J will increase the on farm labor hours worked. In the case of a credit constrained household, the household will invest in on-farm capital because *J* has now relieved the credit constraint. This investment will increase the marginal productivity of labor relative to the off-farm wage rate. Appropriately, the sign of (64) depends on the relationship between the marginal product of capital and the

interest rate. If a household is credit constrained, the marginal product of capital will be less than the interest rate.

Again due to the credit constraint, and the sub-optimal investment in capital, one would expect that an increase in income from remittances would increase investment in capital such that an increase in *J* will increase investment in K. The relationship is determined by:

$$\frac{dK_1}{dJ} = \frac{(f_{K_1} - r)(U_{C_1C_1} f_{R_1R_1}) + U_{C_2C_2} f_{R_1R_1})\sigma_2}{A} \tag{65}$$

The relationship $\frac{dK_1}{dJ}$ is positive if $f_{K_1} - \frac{U_{C_2C_2}}{U_{C_1C_1}} < r$. This suggests that if the marginal product of capital minus the ratio of utility's second order conditions for period one and two is less than the interest rate, an increase in income will cause an increase in investment in agricultural capital.

Since it was shown that $\frac{dR_1}{dJ} > 0$, it must be that off-farm labor will decrease with an increase in *J*, since the one individual has a fixed time allotment and will reallocate labor back on to the farm with an increase in *J*. Again, assuming that $f_{K_1} - \frac{U_{C_2C_2}}{U_{C_1C_1}} < r$, the relationship between market work M_1 and an increase in income is negative, $\frac{dM_1}{dJ} < 0$, as shown by:

$$\frac{dM_1}{dJ} = \frac{(f_{K_1} - r)(U_{C_1C_1} f_{R_1K_1}) + U_{C_2C_2} f_{R_1K_1})\sigma_2}{A} \tag{66}$$

Equation (66) is positive considering the convexity properties above, consistent with expectations. In summary, comparative statics on the agricultural household model with a credit constraint indicate that an increase in income will increase capital investment on-farm leading to a reallocation of labor from off-farm work to on-farm work.

Marshallian household labor supply functions are similar to those in case 3, but now *r* is a shadow value (ρ) because of the credit constraint:

$$R_t^{F*} = R(w_1, w_2, \rho(.), \beta, \overline{G}, K_0, J) \quad (67)$$

$$M_t^{F*} = M(w_1, w_2, \rho(.), \beta, \overline{G}, K_0, J) \quad (68)$$

$$H_t^* = H_t(w_1, w_2, \rho(.), \beta, \overline{G}, K_0, J) \quad (69)$$

and an optimal level of *K* is determined by:

$$K_1^* = K_1(w_1, w_2, \rho(.), \beta, \overline{G}, K_0) \quad (70)$$

where $\rho = \rho(w_1, w_2, \overline{B}, \overline{G})$.

If the combined results are examined from of cases 3 and 4, relationships between w_{us} and on and off-farm labor allocations can be examined. To examine these relationships (67) and (68) are differentiated with respect to $w_{us,}$.

$$\frac{\partial R}{\partial w_{us}} = \left(\frac{\partial R}{\partial \rho} \frac{\partial \rho}{\partial J} + \frac{\partial R}{\partial J} \right) \frac{\partial J}{\partial w_{us}} \quad (71)$$

Here the relationship between *R* and w_{us} works through ρ, and the optimal level of remittances, *J**. This investment will increase the marginal product of *R* so the relationship between ρ and *R* is $\frac{\partial R}{\partial \rho} < 0$. Consistent with NELM, an increase in migrant wage will increase remittances such that $\frac{\partial J}{\partial w_{us}} > 0$. The relationship between *R* and *J* is shown above to be positive when the household is credit constraint, while it was shown that there is no relationship between w_{us} and *R* when households operate in functioning capital markets.

Given these predicted signs, in a credit constrained household, the relationship between on-farm work and the wage in the USA is positive. Therefore, with an increase in the U.S. wage

rate, leading to an increase in remittances, a credit constrained household will increase their on-farm work hours. However, if the possibility of hiring a laborer is present, and hired labor is a perfect substitute for family labor, the relationship between remittances and family labor is ambiguous, since we would assume that $\frac{\partial R}{\partial J} < 0$, and then the overall sign of $\frac{\partial R}{\partial w_{us}}$ is unknown. Further, total labor (family labor plus hired labor) will be affected only by remittances if there is a credit constraint present. These relationships will be empirically estimated.

In the case of off-farm work the relationship is similar to that of on-farm labor as shown here:

$$\frac{\partial M}{\partial w_{us}} = \left(\frac{\partial M}{\partial \rho} \frac{\partial \rho}{\partial J} + \frac{\partial M}{\partial J} \right) \frac{\partial J}{\partial w_{us}} \tag{72}$$

Since *J* relaxes the credit constraint and increases the marginal product of on-farm labor, $\frac{\partial M}{\partial \rho} < 0$. This makes the first term in (72) positive. In the second term as shown above, $\frac{\partial M}{\partial J} < 0$. People will either decrease their off-farm work because they buy more leisure with an increase in remittances, or because hired labor is not a perfect substitute for family labor and the family (the female in this model) will reallocate their labor back to the farm.

Finally, the decision to migrate is jointly made by the household members. Substituting (67) through (70) into the original household utility function we can obtain the credit constrained household's indirect utility function that characterizes the household's decision whether or not to send a migrant.

$$Mig^* = V(w_1, w_2, J, w_{usa}, N_{usa}, \beta, \overline{B}, K_0, \overline{G}) - V(w_1, w_2, \beta, \overline{B}, K_0, \overline{G}) \tag{73}$$

where $Mig = 1$ if $Mig^* > 0$ and

$Mig = 0$ if $Mig^* \leq 0$

This relationship indicates that if the indirect utility of the household facing a credit constraint with a migrant, is greater than that without a migrant, a household will send out a migrant. It is also possible that the household's labor supply would respond to the act of migration itself in anticipation of receiving remittances in the future. If this is the case, the above hypothesized relationships would still hold, but the anticipation of remittances upon migration would induce the change in labor allocation rather than the flow of remittances themselves.

The null hypothesis, under the assumption of no credit constraint, is that an increase in remittance will decrease hours of all household labor types. However, in a credit constrained household, the null hypothesis is that an increase in remittances will increase on-farm labor hours, and decrease off-farm labor hours. However, these relationships may be complicated by the potential for hired labor to be used on-farm. Given the potential ambiguity of the remittance and household labor relationship, empirical evidence is needed to clarify the underlying relationship.

4. Empirical Strategy

The empirical analysis presented in this paper estimates the hypothesized relationship presented in the theoretical section between international migration, remittances, and household labor supply in El Salvador[9]. However, there are considerable econometric challenges to estimating these relationships. The fundamental problem is that the migration decision, remittances, the future household labor supply are jointly decided and therefore estimating the labor supply response to remittances conditional on migration using OLS will result in biased

[9] A broader set of relationships than presented in the theoretical section are estimated here.

estimates. As such, the impact of unanticipated "shocks" to remittances on the migrant-sending household's labor supply must be considered. For example, in explaining remittances, unanticipated changes in both the U.S. wage rate and U.S. unemployment rate in the destination city can be considered to be "shocks" that either affect the benefits to a household from sending a migrant, or the ability of the migrant to send remittances. In this sense, this model considers the impact of U.S. labor market conditions for non-resident Latino workers on labor supply decisions in El Salvador. To fully explore the migration, remittance, and labor supply relationship, determinants of migration and remittances are first estimated and presented separately after which the labor supply equations are estimated.

a. Econometric Model of Migration

The migration decision can be estimated using a random effects probit model. The random effects probit takes the form:

$$Y_{it}^{*} = x_{it}^{HH}\beta + x_{it}^{CC}\gamma + \mu_i + \varepsilon_{it} \tag{74}$$

where x_{it}^{CC} is a set of exogenous, community characteristics that affect a household's migration opportunity such as the percent of households in the community that receive remittances (which increases the community's migrant network, therefore decreasing migration transaction and adjustment cost in the destination) and distance to a paved road (which is a proxy for the household's remoteness which may also increase the cost of migration) as well as a set of household characteristics, x_{it}^{HH}, that may affect migration, μ_i is a household specific error term $\mu_i \sim N(0, \sigma_\mu^2)$ and $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$ is an error term that varies within and across households. Both components of the error term are assumed to be mutually independent and identically distributed random variables with means of zero and variances as defined above. A random effects probit is

chosen over a fixed effects logit, or conditional logit, because random effects probit estimates can be used to calculate the probability of migration for a given household given a certain set of characteristics, and this is not possible in the case of the conditional logit (Greene, 2000). Y_{it}^{*} is an unobserved latent variable representing utility from migration. Y_{it} which is observed is related to Y_{it}^{*} as follows:

$$Y_{it} = 0 \text{ if } Y_{it}^{*} \leq 0 \tag{75}$$

$$Y_{it} = 1 \text{ if } Y_{it}^{*} > 0 \tag{76}$$

The likelihood function for the random effects model is defined by Guilkey and Murphy (1992).

b. Remittances Models

Estimating the impact of migration on the levels of remittances received is problematic for two reasons. First, migration in time *t* may increase remittances at time *t+1*, but additionally remittances received at time *t+1* may finance migration in the next period, *t+2*. The relationship between migration and remittances introduces an endogeneity problem if one were to try to simply regress a migration variable on levels of remittances. Coefficient estimates in this case would be biased upward. Second, data on U.S. wage rates, w_{us}, and U.S. unemployment rates, N_{us}, two variables that are hypothesized to influence the level of remittances a household receives described below, are available only for households who have a migrant. To account for the selection bias induced by the non-random characteristics of households which receive remittances, two models are estimated which examine factors influencing levels of remittances: (1) a household fixed effects model and (2) a Heckman selection model estimated only for households that receive remittances.

Explanatory variables in the conditional remittance equation that determine the ability of the migrant to send remittances are (1) the average wage rate in the destination city of migrants in the United States of non-resident Latino workers, as calculated from the U.S. Current Population Survey, and (2) the unemployment rate of this same population in the destination city. The conditional remittance equation is conditional on migration, so only households that have migrants are included in the estimation of this equation. The remittance equation is:

$$J_{it} = x_{it}^{HH}\alpha_1 + Z_{it}\alpha_2 + \varepsilon_{it} \qquad (77)$$

where x_{it}^{HH} is a set of household characteristics that influence the level of remittances (J_{it}), Z_{it} is the wage rate and the unemployment rate in the destination U.S. city, and ε_{it} is a normally distributed error term. Equation (77) is estimated, only using data only for households that had a migrant at some point during the panel using a household fixed effects model.[10]

It is hypothesized however, that migrant households may have specific characteristics that would increase the probability of migration (ie. a community migrant network, or different risk preferences). To correct for this possible selection bias in receiving remittances, a Heckman selection model is also estimated to explain remittances. The selection equation is identified using the variable that measures the household's distance to a paved road as well as the percent of households in a given community that receive remittances, both of which are hypothesized to influence the probability of selection into migration for a given individual household. Estimates from both the household fixed effects remittance model and the Heckman selection model are compared.

In addition to explaining remittance levels using panel data, the 2002 cross-section is also used independently, excluding data for other panel years. This cross-section is used because

[10] A random effects model and a first difference model were estimated for comparative purposes. Results presented in the next section are generally robust to different specifications.

there is more detailed information on the migrants in the later collection years of the survey. For example, the gender of the migrant is known in the 2002 survey where it was unknown in previous panel years, as is the relationship between the migrant and the head of the household. The Heckman selection model is again estimated, using distance to a paved road, and the percent of households that receive remittances to identify the selection equation. U.S. wages rates and unemployment rates for male and female non-resident Latino workers are used along with other household characteristics to explain remittance levels.

c. Labor Supply Estimation Strategy

Labor supply equations are estimated using (1) a household fixed effects model and (2) a first differences model. It is expected that these results will be very similar given the similarity of the fixed effects and first difference specifications. The labor supply model is estimated using instrumental variables in levels with household fixed effects[11]. The outcome model estimating household labor supply (H_{jt}) is:

$$H_{jt} = \alpha_i + x_{it}^{HH}\gamma_1 + \gamma_2 J_{it} + \gamma_3 Migr_{it} + \varepsilon_t \qquad (78)$$

where α_i is a household level fixed effect. Household labor supply is also explained using a first differences specification:

$$\Delta H_{jt,t-1} = \Delta x_{it,t-1}^{HH}\gamma_1 + \gamma_2 \Delta J_{it,t-1} + \gamma_3 \Delta Migr_{it,t-1} + \Delta\varepsilon_{t,t-1} \qquad (79)$$

where ΔH_{jt} is a measure of change in labor hours of labor type j at time t, Δx_{it}^{HH} is a set of household demographic change variables for household i at time t, ΔJ_{it} is the change in

[11] The suspected selection bias of migrant households is somewhat mitigated by using household fixed effects.

remittances received by a household *i* at time *t*, $\Delta Migr_{it}$ is the change in migration status of household *i* at time *t* and $\Delta\varepsilon_{it}$ is a time specific white noise random error term[12].

To examine the response of labor hours to remittances 12 different types of household work were used as dependent variables, all measured in hours of work. These 12 types include total labor hours (on and off farm), including hired labor. This aggregate measure is then divided into on-farm work for men, women, children, total family on-farm and hired on-farm labor, off-farm work for men, women, and children, male and female work in non-agricultural self-employment, and household work. Explanatory variables used in these models include household characteristics, changes in El Salvador's off-farm wage and government transfers as well as changes in migration and remittances.

Both household fixed effects models and first differences models use data only from households that have or had a migrant at some point during the panel years. Therefore, when interpreting the change variables, for example change in migration status, this is telling us how a household changes their labor allocation after their migration status changes from 0 (no migrant) to 1 (having a migrant).

d. Data

This section describes the data used in the empirical analysis as well as provides descriptive statistics comparing remittance receiving households with non-remittance receiving households. Given the panel structure of the dataset, the data is described in each of the four years survey data was collected and limited to the 451 households that remained in the panel for four rounds.

We see in table 1 that the number of migrants included in the sample increases from 316 in 1996 to 423 in 2002. The household size decreases, the average number of senior citizens per

[12] A Hausman test is used to test between a fixed effects and a random effects model, and the household fixed effects model was chosen.

household increases, and the average number of children within each household increases. This is consistent with previous demographic studies, which suggest that Latin America is experiencing an increase in its senior citizen population, partly due to out-migration (Brea, 2003). The percentage of households with migrants increases over the eight year period from 35 percent who reported having at least one migrant in 1996 to 43 percent in 2002. The percentage of households that receive remittances increased from 18 percent in 1996 to 35 percent in 2002. The level of remittances, conditional on receiving remittances, in 2002 dollars, also increased from $1,000 in 1996 to $1,700. These descriptive statistics suggest that migration and remittances as an income earning strategy became an increasingly popular livelihood strategy in El Salvador between 1996 and 2002.

Table 2 compares the means of various household characteristics and labor allocation variables of interest between migrant and non-migrant sending households. Results in table 5 indicate that there are significant differences between migrant sending and non-migrant sending households. Migrant households are generally larger, with more senior citizens, less children, more land area and are more likely to be female headed. In terms of labor allocation, these simple comparisons suggest that migrant households decrease their off-farm work hours, for both males, females and total. However, on-farm work hours are not impacted by migration. Only females increase their on-farm work hours in migrant households but this difference is only significant at the 10 percent level. On-farm labor being unchanged under different migration states may be a result of on-farm investment induced by remittances in migrant households and thus on-farm labor is used to complement this on-farm investment. These issues will be explored further in the following section. These results provide only preliminary evidence, of course, of

the differences between migrant and non-migrant households given that these comparisons do not control for other factors that likely affect the outcomes of these comparisons.

5. Results

Determinants of Migration

Table 3 provides a description of all the variables used in the empirical analysis. Table 4 reports the empirical results estimating the probability of migration using a random effects probit model (column 1). Results from a restricted random effects probit model (column 2) and marginal effects probit model (excluding random effects) (column 3), are presented. The dependent variable in all models in Table 4 equals 1 if the household has a migrant and 0 if the household does not have a migrant at the time of the survey.[13] The average number of years that a migrant has been in the U.S. is 8.2 years. Over 75 percent of migrants in the survey have been in the U.S. for less than 10 years.[14] This 75 percent are more likely to have a strong connection with the sending household. If a large majority of migrants in the survey had been in the U.S. for more than 10 years, it may be difficult to identify the outcomes of migration and remittances on the sending household, since the relationship between the sending household and migrant may have eroded over time.

Results are consistent across the two specifications presented in Table 4. The probability of migration increases by 1.5 percent for an individual household with a one percent increase in the number of households within the community that receive remittances (column 1).[15] This

[13] Having a migrant is reported by the household in the survey as well as the number of years the migrant has been away from the household.
[14] Restricting the sample to include only migrants that have been in the U.S. for less than 10 years does not change the empirical results dramatically.
[15] This variable comes from the Salvadoran National Household Survey and does not necessarily include the households included in the panel data set used in this study.

variable is a proxy for the strength of the community's migration network. As the migration network increases, presumably the cost of migration decreases for those individuals with access to this network. Contrary to expectations, distance to a paved road has no significant impact on the probability of migration. Results suggest that the probability of migration is not influenced by the age of the household head. An increase of one senior citizen in the household increases the probability of migration by 33 percent (column 1). Education of the household head was tried and an explanatory variable in an earlier specification, but it had no effect on the probability of migration. Asset holdings were also considered as determinants of migration, however land and livestock holdings are endogenously determined with migration so they are not reported in the final specification.[16] This model also controls for geographic effects with state level dummy variables.

Results representing regional differences in the probability of migration are highly consistent with expectations, given the migration patterns and networks established from the civil war. The departments of Usulután, San Miguel, La Union, and Cuscatlán, represent departments in the east and north of the country, where civil violence was the most intense because these departments were rebel strongholds during the civil war. As such the probability of migration out of these departments compared to Ahuachapán (the excluded department in the west of the country) is significantly higher.

Determinants of Remittances

[16] Results pertaining to asset holdings in previous models seem to have little effect on the probability of migration, with livestock value having no significant effect on migration, and land area having a positive, but only weakly significant effect on the probability of migration. The land area result may seem counterintuitive, however the poorest household may not engage in migration because of the high cost of passage. Therefore more "land rich" households may be more likely to engage in migration because they are more able to finance the migration journey and may be more hurt by missing credit markets. However, given the likely endogeneity of land area, these results should be taken with caution.

Remittance sending behavior is influenced by a complex set of underlying relationships that exist between the migrant and the remittance-receiving household. Migrants have many potential motives to send remittances. To explore the richness of migrant information in the 2002 data set, both cross-sectional results for 2002 explaining remittances, as well as panel results are presented.

2002 Cross-sectional Results

The cross-sectional results are estimated by OLS regression and are presented in Table 5[17]. The cross-sectional approach exploits the detailed information on migrant characteristics collected in 2002 survey. This model explores how the gender of the migrant and the migrant's relationship to the household head impact the amount of remittances received by the household.

Wage rates from the U.S. Current Population Survey are matched to each individual migrant according to the destination city of the migrant and the gender of the migrant[18]. Where the destination was not available the national average wage rate was used in place of a city-specific wage rate. The average wage rate for non-resident Latino men in 2002 is $US 379 per week and for non-resident Latino women the average wage rate is $US 322 per week. Women send $US 2,157 in remittances per year and men send $US 2,033. Without controlling for other factors, the difference between the two averages is not significantly significant. Column 1 and column 2 (Table 5) are both estimated using OLS, however column 1 includes information on the relationship between the household head and the migrant. In column 1 the US wage rate and the U.S. unemployment rate do not affect the level of remittances received. However, the relationship between the household head and the migrant are very important in determining the

[17] A standard OLS was also estimated and results are very similar in significance, magnitude, and sign across the two specifications.

[18] For example, if the household reports a female migrant in Los Angeles in 2002, the average wage rate for a non-resident Latino female in Los Angeles is used for this migrant's wage.

yearly amount of remittances. If the migrant is the son of the household head he sends $US 1,229 more in yearly remittances than if the migrant is an "other" family relative.[19] If the migrant is the daughter of the household head she sends $US 1,445 more than other relatives. If the migrant is the brother of the household head, they do not send significantly more than other relatives, however if the migrant is the sister she sends $1,469 more than other relatives. Not surprisingly, being the household head has the strongest effect on remittances sent. The household head sends $US 2,553 more than other relatives.

Column 2 excludes the relationship variables between the household head and the migrant and looks at aggregated gender impacts. When the relationship variables are excluded (which implicitly are also gender variables) results suggest that when the US wage increases by one dollar per week remittances increase by $11 per year from all migrants. The unemployment rate does not affect the level of remittances being sent. If a migrant is a female they send $US 768 more per year than their male counterpart. Column 2 results also indicate that if the remittance-receiving household is female-headed this household will receive $US 781 more dollars per year than if the household were a male-headed household.

Panel Data Results

The remittance equation using panel data, presented in Table 6, is estimated both by a household fixed effects model (column 1)[20] and a Heckman selection model (columns 2 and 3). The selection equation includes the percentage of households in the community that receive remittances, and the distance from the household to the nearest paved road. Theory presented in Section 3 suggests that since the migrant and household are maximizing joint utility, the level of remittances will increase when the U.S. wage rate increases and will decrease when

[19] Familial relationships excluded from this regression as a comparison group include cousins, in-laws, grandchildren, etc.
[20] A fixed effects model was chosen over a random effects model based on a Hausman test result.

unemployment increases. Empirical results strongly support this theoretical result. Empirical results suggest that when the wage in the U.S. for migrants increases by one dollar per week, remittances increase by $US 8.60 per year (column 1), or by $US 4.00 per year (column 2). An increase in the unemployment rate for non-resident Latino workers has a negative impact on remittances, but it is only weakly significant, specifically a 1 percentage point increase in the unemployment rate decreases the yearly remittance by $US 94.00. Further, remittance levels to female headed households are $US 803.00 ($US 550, column 2) higher than those to male headed households, which is consistent with the cross-sectional results.

The Heckman selection equation supports results found in the migration probit model: that a one percentage point increase in the percentage of households that receive remittances at the community level increases the probability of migration by 1.6 percent. Also consistent with the migration probit, the distance to a paved road from a household has no effect on the likelihood of migration. The likelihood ratio test, which tests the independence of the selection equation and outcome equation, suggests that these two are not independent and (as expected) there is a selection bias in remittance receiving households. The λ in the selection model is negative and significant. This result suggests that the error term in the selection equation and the primary equation are negatively correlated. The negative and significant λ indicates that the unobservable characteristics that make participation, or selection into migration, more likely decrease the amount of remittances sent back to the household.

Determinants of Household Labor Supply Allocations

Tables 7, 8, 9, and 10 report the econometric results explaining the response of labor hours supplied to migration and remittances, by labor type. While the theoretical model

examines male and female aggregate labor supplies, the empirical results disaggregate labor type to include children's labor as well as on and off-farm labor, self-employment and housework. According to theory, when a household is not credit constrained an increase in remittances will have no effect on labor supplied.[21] If a household is credit constrained, the change in total labor hours supplied in response to migration and remittances is theoretically ambiguous, but households will reallocate labor back onto the farm and out of the off-farm labor market.

A first difference (FD) two stage least squares model (Table 8) and a fixed effects (FE) model in levels (Table 7) are estimated for on-farm labor supplies[22]. For total household labor supply, FD results (table 8, column 1) suggest that remittances have no significant effect on total household labor hours. Similarly migration status also has no significant effect. These results on aggregate labor hours indicate that (1) the family's labor allocation is not responsive to migration and remittances, or (2) there is a reallocation between types of labor that is induced by migration and remittances that has a net-zero effect on overall labor supply[23]. The FE model also yields insignificant results (Table 7, column 1).

FD results suggest that when a household engages in migration (i.e. goes from a migrant status of 0 to 1), total on-farm work hours increase by 2,090 hours per year (Table 8 column 2). The FE specification similarly estimates that work hours will increase by 2,125 hours per year when a household engages in migration. However, surprisingly, the effect of a change in the amount of remittances is not significantly different from zero for total farm labor in either specification. Adult males, adult females, and children all have positive and significant changes in their on-farm labor hours with a positive change in the migration status of the household

[21] This result is based on the fact that the theoretical model excludes leisure. If leisure were present, an increase in remittances would increase the number of leisure hours purchased and total labor supplied would decrease.
[22] Previous estimates of this model included a Heckman selection correction term, however this had no qualitative impact on either the estimates or the standard error estimates.
[23] Measurement error is also possible in the reporting of family labor hours which may lead to imprecise estimates.

(Table 8 columns 3,4, and 5). Adult men significantly increase their on-farm labor hours by 994 hours per year in response to a change in migration status. This change is nearly four times as large as the change for children, who increase their hours by 206 hours per year, and adult females, who increase their hours by 226 hours per year. This is reasonable given that men do most of the on-farm agricultural work in El Salvador. A change in migration has no effect the change in hired labor hours. It is possible that hired labor is not a perfect substitute for family labor. The FE model results in Table 7 (columns 3,4, and 5) are consistent in signs with the FD model, but individual time allocations for men and women are insignificant.

The empirical results for on-farm labor consistent with theoretical results presented in case 4 in the theoretical. Empirical estimates suggest that an increase in migration will increase on-farm work for all family members. If households are responding to an anticipated flow of remittances, we can deduce two things from these results. Firstly, if the household was *not* credit constrained, we would expect no change in labor allocations with an increase in migration or remittances. Since empirical estimates indicate an increase in on-farm work when a household engages in migration, these provide evidence that the household is credit constrained and migration is helping to overcoming this credit constraint. Second, if hired labor and family labor are substitutes a significant and positive increase in hired labor is hypothesized. However, since family on-farm labor increases significantly, and hired on-farm labor has no significant change, this indicates that hired and family labor are not substitutes. Empirical estimates imply that, consistent with theoretical predictions, migration relieves a credit constraint, and family on-farm labor increases.

Changes in off-farm work are shown in Tables 9 and 10. One would expect that if all members are increasing their on-farm work, there would be a parallel decrease in other types of

work. However, according to the FD results, if a household engages in migration this leads to a decrease of 1,981 yearly off farm work hours for adult males (Table 10 column 2). However, there is no significant change on other household members' off-farm work allocations (columns 1 and 3). It is possible that the significant decrease in male off-farm work is due to the fact that a majority of migrants are adult males, or that much of the on-farm field labor is done by males. In the FE model (Table 9) adult men, women, and children all have insignificant coefficients for off-farm work (column 1, 2, and 3).

Contrary to previous studies (Amuedo-Dorantes 2006; Funkhouser, 1992), results in Tables 9 and 10 indicate that a change in migration or remittances has no significant impact on non-agricultural self-employment in El Salvador. There is, however, a significant increase in housework hours in response to a positive change in migration status in Table 10 (column 6). When a household engages in migration, the total yearly housework hours increase by 1,923 hours. This result may reflect investment in household improvements and that respondents are reporting household improvement labor hours, such as making additions, or renovations, as household labor hours. This is consistent with anecdotal evidence that suggests that a large portion of remittances is invested in home improvement, such as upgrading the building material from wood to concrete block. Further, the increase in housework hours may also represent an increase in female labor on-farm hours. For example, home gardening or small livestock care may be included in housework hours. Lastly, consistent with expectations, a positive change of one dollar in the Salvadoran agricultural wage increases yearly off-farm work hours by 50 hours for women and 86 hours for men (Table 10 columns 1 and 2).

Remittances, surprisingly, have no significant impact on on-farm labor allocations. There are several potential explanations for this outcome. It is possible that the household reallocates

their labor as soon as migration occurs with the anticipation of remittances, and therefore changes in remittances do not impact the labor allocation of the household. In this sense, migration serves a different function than remittances. An alternative explanation is that migration may serve as an insurance mechanism for the household, allowing them to undertake more risky on-farm entrepreneurial activities. This provides an incentive for the household to reallocate labor back to the farm[24]. Yet another explanation may be that the instrumental variables used to predict remittances are not as strong as those used to predict migration.

Validity of Empirical Estimates for Labor Supply Equations

The individual remittance and migration equation estimates were presented partly to check the validity of instruments that are used in the subsequent labor supply estimates, given that remittances and migration are both endogenous to household labor supply decisions. The excluded instruments (those exogenous variables included in addition to the explanatory exogenous variables) are U.S. wage rate, U.S. unemployment, distance between the household and a paved road, and the percent of the households in the community that receive remittance. There are several potential sources of biases and inconsistency that need to be addressed.

Firstly, the instruments must satisfy the condition that $E[\varepsilon|Z]=0$, where Z is a vector of exogenous instrumental variables. An overidentification test[25] for panel data fixed effects is performed on all of the household fixed effect labor supply equations. The null hypothesis is that the equation is properly specified and the instruments are uncorrelated with the error term. Tables 7 and 8 report results for the fixed effect labor supply equations. The p-value for the

[24] This explanation was not considered in the theoretical model.

[25] The over identification test performed is the Sargan test for overidentifying restrictions for panel data fixed effects. This test regresses IV residuals on the full instrument matrix which yields the Lagrange multiplier test. This test statistic is distributed as $\chi^2(g)$, where g is the number of overidentifying restrictions.

overidentification Lagrange multiplier test is shown at the bottom of this table. Only the regression for female on-farm labor fails Sargan's overidentification test, which casts doubt on the validity of the specification and instruments used in this equation and suggests that these results should be treated with caution. We fail to reject the null hypothesis that the excluded instruments are uncorrelated with the error term and appropriately excluded from the estimated equation in all other cases in Tables 7 and 9. However, this test is valid only if there are as many good instruments as there are variables that are being instrumented, which cannot be tested. Also, in the case of the adult male, non-agricultural self-employment equation the null hypothesis that the excluded instruments are valid instruments is rejected at the 5 percent level, however at the 10 percent level we fail to reject the null hypothesis. Therefore, these results should also be interpreted with some caution.

Secondly, a Hausman test establishes that implementing a simple OLS model to explain household labor supply by migration and remittances directly leads to a violation of the classical OLS assumption that $E[\varepsilon|X]=0$. We reject the null hypothesis that there is no systematic difference between OLS and instrumental variable estimates, and proceed with an instrumental variable approach.

Given the difficulty in finding "good" instruments to predict migration and remittances, not to mention good instruments that vary over time and households, it is possible that these models suffer from problems induced by using weak instruments. In small samples, IV estimates are similar to OLS estimates and increasingly so as the number of instruments increases. One way to check this finite sample bias is to check the F-test from a regression of the excluded instruments on the potentially endogenous variables. F-tests from regressing migration and remittances on the excluded instruments are 19.61 and 26.23, respectively. These results

indicate that the IV estimates are far less biased than OLS estimates. This result suggests that the excluded instruments are strong enough to make the IV estimates less biased than OLS estimates.

6. Concluding Remarks

Migration is an increasingly popular livelihood strategy for many rural households in El Salvador. This paper explores the impact of migration and remittances on agricultural households' labor allocations. It uses changes over time and a household fixed effects model correcting for selection bias to investigate how changes in migration status and remittances received affect different types of household labor supplied.

Examining the determinants of migration itself, we see that the community migration patterns[26] have a significant impact on the probability of migration for any given household and further that the physical distance of the household to a paved road, a proxy for the remoteness of the household, contrary to prior expectations, does not have an impact on migration.

Results explaining the amount of remittances received indicate that the gender of the migrant has a significant impact on the quantity of remittances sent, with women sending over $US 700 more per year than men. Cross-sectional results also suggest that the relationship of the migrant to the household head has an important effect on the level of remittances sent. Specifically, if the migrant is a son, daughter, or had been the household head, these relationships seem to have a particularly strong positive impact on the level of remittances received.

[26] This instrument, while it passes the Hausman and overidentification test, remains potentially problematic since it is possible that the same characteristics that affect the community's migration patterns also affect labor allocation patterns. This is mitigated by the knowledge that community migration patterns are determined largely by the historic patterns of fighting in the civil war.

For household labor allocations, a change in the migration status of the household has a much broader impact on household labor allocations than a change in the level of remittances received. Specifically, a positive change in migration status significantly increases on-farm labor hours for all family members and significantly decreases male off-farm labor hours. These results suggest that migrant households are using migration to overcome some credit constraint, and further that hired labor is not a perfect substitute for family labor. Household work hours also are significantly and positively affected by a positive change in migration status. Surprisingly, a change in migration status has no impact on non-agricultural self-employment. Remittances in both the empirical specifications presented apparently have no impact on labor allocations.

Table 1. Descriptive Statistics

	1996	1998	2000	2002
Individual Characteristics				
Number of Individuals (including migrants)	3387	3292	3291	3,135
Number of sending household members	3071	2992	2888	2,712
Number of migrants	316	300	403	423
Percent of females in sending households	499%	5108%	56.40%	57.51%
Average age of individuals in sending households	24.86	24.72	25.97	26.75
Household Characteristics				
Number of Households in Sample	451	451	451	451
Total Household Size	7.51	7.30	7.30	6.95
Household Size (excluding migrants)	6.81	6.63	6.40	6.01
Number of Migrants per household	0.70	0.67	0.89	0.94
Average Number of Household Senior Citizens	0.99	0.91	1.22	1.29
Average Number of Children in HH	2.67	2.77	2.60	2.38
Percentage of Households with Migrants	34.59%	32.82%	43.02%	42.57%
Percentage of Households that Received Remittances	18.40%	21.29%	28.38%	35.03%
Number of HH that received Remittances	83	96	128	158
Average Remittances Received (all households)	$161	$203	$370	$615
Average Remittances Received conditional on receiving remittances	$873	$952	$1,304	$1,756
Average Remittances Received for Remittance Receiving HH in 2002 dollars	$1,001	$1,051	$1,362	$1,756

Source: Calculated by the author using OSU BASIS data

Table 2. Comparison of Household Characteristics between Migrant and Non-Migrant Sending Panel Households

Variable	Non-Migrant Household Mean	Migrant Household Mean	Difference	t-test different than zero (p-value)
Household Size	7.0	8.5	-1.5	0.0000
	0.0803	*0.1399*	*0.1500*	
Average Number of Senior Citizen (65+) in the Household	0.3	0.9	-0.6	0.0000
	0.0241	*0.0576*	*0.0545*	
Average Number of Children (<16 years) in the Household	2.8	2.6	0.2	0.0373
	0.0664	*0.1022*	*0.1166*	
Remittances Received by the Household (average 4 years)	0.0	905.5	-905.5	0.0000
	0.0000	*59.1938*	*46.0329*	
Hours of Total Household Off-farm Work	2,972.5	1,884.9	1,087.6	0.0000
	118.5922	*114.0427*	*176.4019*	
Hours of Total Household Off-farm Work - Female	760.1	461.4	298.7	0.0000
	46.3605	*42.1374*	*68.0238*	
Hours of Total Household Off-farm Work - Male	2,132.9	1,309.8	824	0.0000
	107.8466	*75522*	*149.9444*	
Hours of Total Household Off-farm Work -Children	45.2	91.7	62.7	0.2696
	8.2219	*52.4792*	*20.4320*	
Hours of Total Household On-farm Work - Female	159.7	200.3	-40.6	0.0536
	10.0732	*21.2492*	*20.9959*	
Hours of Total Household On-farm Work - Male	407.4	399.3	8.2	0.7822
	17.8211	*210659*	*29.4879*	
Hours of Total Household On-farm Work -Children	62.3	50.2	12.1	0.1808
	5.9567	*6.2459*	*9.0694*	
Household of Total Household Housework	1,214	1,154	60.0	0.2012
	27.7946	*39.1296*	*46.9383*	
Total Livestock value	891.96	1498.99	-607.03	0.1374
	245.0122	*328.6217*	*405.6703*	
Total Land Area (hectares)	1.24	2.34	-1.09	0.0000
	0.0999	*0.1866*	*0.1940*	
Share of Female Headed Households	0.10	0.17	-0.07	0.0000
	0.0088	*0.0144*	*0.0160*	
Dependency Ratio (dependents / working age adults)	1.07	0.88	0.19	0.0001
	0.0301	*0.0333*	*0.0464*	

*Standard Errors are in italics

Source: Calculated by the author using OSU BASIS data

Table 3 Description of Variables Used in Empirical Analysis

Variable Name	Description	Measurement
% of households that receive remittances	Percent of Households in the municipality that received any remittances in the survey year. Where municipal data was unavailable state level data was used for a given household.	Percentage
Distance to Paved Road from the HH (in km)	Distance reported by the household between the household and the nearest paved road	Kilometers
Age of HH Head	Age of the person reported as the household head.	Years
Age of HH Head Squared	Age of the person reported as the household head squared	Years
Dependency Ratio	Number of people over 65 years and under 16 years divided by the members between 16 years and 65 years.	Ratio
Number of Senior Citizen Present in HH	Number of household members over 65 years old	Number
Female Headed HH	Whether the household head is female	Dummy Variable (=1 if yes)
Number of HH Members	Number of Household Members excluding migrants	Number
Number of Children Present in HH	Number of people in the household less than 16 years old.	Number
Land Area in HA	Land holdings, including rented, owned, borrowed land.	Hectares
Value of Livestock holdings	Reported value of all livestock owned by the household at the beginning for the survey year divided by 1000.	US Dollars
US Wage	Average wage calculated from Bureau of Labor Statistics Current Population Survey, earned by non-resident Latinos in the destination city reported by the household	US Dollars
US Wage Female	Average wage for females calculated from Bureau of Labor Statistics Current Population Survey, earned by non-resident Latinos in the destination city reported by the household	US Dollars
US Wage Male	Average wage for males calculated from Bureau of Labor Statistics Current Population Survey, earned by non-resident Latinos in the destination city reported by the household	US Dollars
Unemployment rate in destination city	Unemployment rate calculated from Bureau of Labor Statistics Current Population Survey, earned by non-resident Latinos in the destination city reported by the household	Percentage
ES Wage	Wage reported for off farm work in El Salvador by the household	US Dollars

Table 4. Probit Models Explaining Migration, El Salvador, 1996, 1998, 2000, 2002.

	RE Probit	RE Probit	Marginal Effects Probit
	(1)	(2)	(3)
% of households that receive remittances	0.015***	0.016***	0.004***
	(0.003)	(0.003)	(0.001)
Distance to Paved Road from the HH (in km)	-0.005	0.000	0.000
	(0.008)	(0.008)	(0.002)
Age of HH Head	0.032		0.006
	(0.021)		(0.004)
Age of HH Head Squared	0		0
	0.000		0.000
Number of Senior Citizens Present in HH	0.331***		0.085***
	(0.044)		(0.010)
Departmental Dummies			
Santa Ana	0.231		0.046
	(0.299)		(0.056)
Sonsonate	0.051		0.002
	(0.328)		(0.058)
Chalatenango	0.52		0.1
	(0.336)		(0.067)
La Libertad	0.362		0.086
	(0.291)		(0.056)
San Salvador	0.217		0.024
	(0.303)		(0.056)
Cuscatlán	-1.109**		-0.178***
	(0.500)		(0.046)
La Paz	-0.314		-0.093*
	(0.370)		(0.055)
Cabanas	0.457		0.083
	(0.399)		(0.079)
San Vicente	0.314		0.046
	(0.393)		(0.076)
Usulután	0.666**		0.148**
	(0.304)		(0.062)
San Miguel	0.575*		0.121**
	(0.301)		(0.061)
Morazán	0.593*		0.129*
	(0.331)		(0.068)
La Union	1.292***		0.329***
	(0.313)		(0.065)
Constant	-2.333***	-0.941***	
	(0.587)	(0.082)	
Observations	1774	1774	1774
Number of households	449	449	

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Columns 1 and 2 are estimated using a random effects probit and column 3 is estimated using a marginal effects probit. The dependent variable is "migration" which takes the value of 1 when a household has one or more migrants and 0 if a household has no migrants.

Table 5. Cross-sectional Model of Remittances (in US dollars), El Salvador, 2002

	(1)	(2)
US Wage	7.564	10.859**
	(4.86)	(5.37)
US Unemployment Rate	38.365	62.777
	(75.55)	(861)
Migrant is a Female (=1 if migrant is female)	312.806	768.446**
	(368.61)	(389.07)
Migrant is Son of HH Head	1,229.727***	
	(279.42)	
Migrant is Daughter of HH Head	1,445.923***	
	(281.779)	
Migrant is Brother of HH Head	24609	
	(377.638)	
Migrant is Sister of HH Head	1,469.658***	
	(444.88)	
Migrant is HH Head	2,55955***	
	(410.348)	
Age of HH Head	-18.257*	-7.328
	(10.70)	(10.31)
Dependency Ratio	326.056	-681.660*
	(385.55)	(396.84)
Number of Senior Citizen Present in HH	-290.915	-35.73
	(188.63)	(205.89)
Female Headed HH	-1443	781.652***
	(293.05)	(289.49)
Number of HH Members	109.53	-606
	(84.66)	(967)
Number of Children Present in HH	-80.238	141034
	(152.43)	(164.86)
Constant	-2,161.75	-2,09113
	(2108.41)	(2287.60)
Observations	413	413
R-squared	0.26	0.05

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in parentheses. Dependent variable is remittances sent by an individual migrant in US dollars. Models are estimated using OLS. Sample includes only international migrants. Some households have more than one migrant.

Table 6 Panel Data Model of Remittances (in US dollars), El Salvador, 1996, 1998, 2000, 2002.

	Fixed Effect Regression	Heckman	
		Regression	Selection Equation
	(1)	(2)	(3)
Unemployment rate in destination city	-85.596**	-64.577	
	(3748.12)	(3932.96)	
US Wage in destination city	8.785***	4.961**	
	(2.29)	(2.30)	
Age of HH Head	108.705**	60.280*	
	(46.64)	(32.44)	
Age of HH Head Squared	-1.006**	-0.519*	
	(0.45)	(0.31)	
Dependency Ratio	117.692	81.471	
	(188.18)	(164.36)	
Number of Senior Citizen Present in HH	14.247	15.896	
	(121.31)	(102.78)	
Female Headed HH	791.054***	710.776***	
	(3043)	(210.87)	
Number of HH Members	-153.073**	-24.415	
	(77.40)	(54.59)	
Number of Children Present in HH	58.031	9.341	
	(110.73)	(81.87)	
ES wage	-39.112	41002	
	(34.01)	(26.74)	
ES transfers	0.051	0.062**	
	(0.03)	(0.03)	
λ		-539.041**	
		(248.88)	
Constant	-3,108.076**	-1,270.56	-0.789***
	(1,515.62)	-1,326.48	-0.046
% of households that receive remittances			0.018***
			(0.00)
Distance to Paved Road from the HH (in km)			0.009*
			(0.01)
Observations	502	465	1528
Number of Households	268		
R^2	0.22		
LR test of independent equations (prob > chi2)			0.0004

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in parentheses.

Table 7 Fixed Effects Instrumental Variable Results for On-Farm Labor Hours in Levels, El Salvador, 1996, 1998, 2000, 2002.

		On Farm Work				
	Total Hours	**Total Farm Hours**	**Female**	**Male**	**Child ***	**Hired**
	(1)	(2)	(3)	(4)	(5)	(6)
Remittance	-0.388	-0.593	-0.062	-0.382	-0.093	-0.056
	(0.63)	(0.45)	(0.07)	(0.27)	(0.07)	(0.22)
Migration Status	1,513.05	2,125.831*	27596	952.789	31988*	585.859
	(1595.25)	(1151.02)	(179.15)	(689.61)	(185.40)	(565.33)
Land Area	16.87	32.062*	2.409	751	-1.338	27.440***
	(25.88)	(18.67)	(2.91)	(11.19)	(3.01)	(9.17)
No. of Senior Citizens in HH	-328.793	-265.843	-22.274	-153.09	-32.28	-58.199
	(291.01)	(209.97)	(32.68)	(125.80)	(3102)	(1033)
Female Head Status	301.547	-41.931	35.663	-12.356	41.407	-106.645
	(565.56)	(408.07)	(671)	(244.48)	(65.73)	(200.42)
Number of HH Members	881173***	186.416**	9.192	142.667***	6.374	28.182
	(120.24)	(86.75)	(170)	(51.98)	(1117)	(42.61)
No. of HH Children	-982.232***	-27376*	-40.017	-174.959*	-5.826	-52.374
	(220.50)	(159.10)	(24.76)	(95.32)	(25.63)	(78.14)
Livestock Value	0.009	0.009	0.002	0.004	0.003**	0
	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
Dependency Ratio	617.908	213.096	38.969	136.765	25.759	11.604
	(429.25)	(309.71)	(48.21)	(185.56)	(49.89)	(152.12)
ES Wage	-17.322	-87.610*	-9.545	-32.313	-10.951	-34.801
	(69.39)	(50.07)	(7.79)	(30.00)	(8.06)	(24.59)
ES Transfers	0.006	0.029	-0.002	0.026	0.002	0.004
	(0.05)	(0.04)	(0.01)	(0.02)	(0.01)	(0.02)
Constant	-1,568.388*	-468.405	-5.021	-318.231	-82.284	-62.869
	(880.84)	(635.55)	(98.92)	(380.78)	(102.37)	(312.15)
Number of Observations	556	556	556	556	556	556
Number of households	231	231	231	231	231	231
Davidson-MacKinnon Test	0.06	0.01	0.07	0.17	0.02	0.18
Overidentification Test	0.92	0.27	0.05	0.17	0.11	0.67

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in parentheses. Children are defined as household members less than 16 years old. All results presented are second stage results.

Table 8. First Differenced Instrumental Variable Results for On-Farm Labor Hours in Levels, El Salvador, 1996, 1998, 2000, 2002.

		On Farm Work				
Explanatory Variables	**Total Hours**	**Total Farm Hours**	**Female**	**Male**	**Child***	**Hired**
	(1)	(2)	(3)	(4)	(5)	(6)
Change in Remittance	0.588	0.02	-0.008	0.042	0.035	-0.051
	(0.42)	(0.25)	(0.05)	(0.16)	(0.04)	(0.15)
Change in Migration Status	-46.583	2,090.687***	226.989*	994.693**	206.615*	707.411
	(1167.92)	(726.95)	(124.67)	(4738)	(119.71)	(449.42)
Change in Land Area	-1.003	18.909	1.194	7.298	-0.017	10.731
	(38.61)	(22.54)	(4.12)	(14.67)	(91)	(1113)
Change in No. of Senior Citizens in HH	39.345	-162.803	-20.836	-4.925	-24.796	-117.417
	(246.50)	(146.35)	(26.31)	(95.26)	(24.10)	(90.48)
Change in Female Head Status	-1,49611*	-661014	64.344	-347.248	-48.853	-3395
	(822.50)	(478.50)	(87.80)	(311.46)	(78.80)	(295.82)
Change in Number of HH Members	340.032**	119.556	0.334	92.435	0.201	29.511
	(160.78)	(95.18)	(17.16)	(61.96)	(15.67)	(58.84)
Change in No. of HH Children	105.903	-18997	-39.579	-45.614	1.964	-107.867
	(300.66)	(180.36)	(32.10)	(117.39)	(29.70)	(111.50)
Change in Livestock Value	-0.099***	-0.067***	0	-0.003	0.003	-0.067***
	(0.03)	(0.02)	(0.00)	(0.01)	(0.00)	(0.01)
Change in Dependency Ratio	-86.563	-82.855	-8.73	-114.268	675	42.416
	(362.73)	(2139)	(38.72)	(138.76)	(35.11)	(131.80)
Change in ES Wage	148.476**	5.312	-4.424	-1.525	1.133	9.721
	(58.79)	(34.16)	(6.28)	(22.23)	(5.62)	(21.12)
Change in ES Transfers	-0.07	-0.028	-0.006	-0.016	-0.007	0.001
	(0.06)	(0.04)	(0.01)	(0.02)	(0.01)	(0.02)
Constant	-642.775	-506.308**	-72.225*	-286.165*	-71.476*	-81.982
	(4035)	(237.14)	(43.04)	(154.35)	(39.05)	(146.60)
Observations	180	181	180	181	181	181

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in parentheses. Children are defined as household members less than 16 years old. All results presented are second stage results.

Table 9 Fixed Effects Instrumental Variable Results for Off-Farm, Self-Employment, and Housework Labor Hours in Levels, El Salvador, 1996, 1998, 2000, 2002.

	Off Farm Work			Non-Agricultural Self Employment		Housework
	Female	Male	Child*	Female	Male	
	(1)	(2)	(3)	(4)	(5)	(6)
Remittance	0.137	0.289	-0.034	-0.075	-0.112	-0.397
	(0.22)	(0.45)	(0.08)	(0.10)	(0.23)	(0.35)
Migration Status	71.107	-1,691.75	50.336	366.504	591.019	851.583
	(561.86)	(1148.72)	(199.25)	(250.17)	(589.43)	(888.44)
Land Area	9.163	-27.646	-0.828	1.674	2.444	-14.38
	(9.12)	(18.64)	(43)	(4.06)	(9.56)	(14.41)
No. of Senior Citizens in HH	5.659	131.098	10.706	-78.045*	-132.368	-8449
	(102.50)	(209.55)	(36.35)	(45.64)	(107.53)	(162.07)
Female Head Status	175.986	28.474	40.518	92.188	6.312	119.211
	(199.19)	(407.25)	(70.64)	(88.69)	(208.97)	(314.97)
Number of HH Members	138.610***	460.715***	25.624*	16.183	56.426	111.136*
	(42.35)	(86.58)	(15.02)	(18.86)	(44.43)	(66.96)
No. of HH Children	-89.343	-52879***	3645	-36.04	-9639	-57.067
	(77.66)	(158.78)	(27.54)	(34.58)	(81.47)	(122.80)
Livestock Value	-0.004	0.004	0	-0.001	0.001	-0.003
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)
Dependency Ratio	96.454	137.536	-30.914	55.738	145.998	132.597
	(151.18)	(309.09)	(581)	(67.31)	(158.60)	(239.06)
ES Wage	28.109	6556	-6.925	-0.105	-14.147	-16.192
	(24.44)	(49.96)	(8.67)	(10.88)	(25.64)	(38.64)
ES Transfers	-0.008	-0.028	-0.001	0.004	0.009	0.026
	(0.02)	(0.04)	(0.01)	(0.01)	(0.02)	(0.03)
Constant	-788.981**	270.19	-106.982	-134.077	-340.133	337.81
	(310.24)	(634.28)	(110.02)	(138.13)	(325.46)	(490.56)
Number of Observations	556	556	556	556	556	556
Number of households	231	231	231	231	231	231
Davidson-MacKinnon Test	0.15	0.48	0.82	0.12	0.17	0.35
Overidentification Test	0.12	0.55	0.88	0.72	0.93	0.07

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in parentheses. Children are defined as household members less than 16 years old. All results presented are second stage results.

Table 10 First Differenced Instrumental Variable Results for Off-Farm, Self-Employment, and Housework Labor Hours in Levels, El Salvador, 1996, 1998, 2000, 2002.

	Off Farm Work	Non-Agricultural	Housework

				Self Employment		
Explanatory Variables	**Female**	**Male**	**Child***	**Female**	**Male**	
	(1)	(2)	(3)	(4)	(5)	(6)
Change in Remittance	0.192	0.444	0.06	-0.019	-0.046	0.138
	(0.18)	(0.30)	(0.39)	(0.16)	(0.08)	(0.30)
Change in Migration Status	-531.47	-1,981.864**	678.682	282.747	-160.807	1,92863**
	(517.48)	(894.05)	(1155.98)	(457.55)	(237.02)	(868.81)
Change in Land Area	25.817	-42.047	5.79	0.485	-1146	-1.95
	(16.04)	(27.72)	(35.84)	(14.19)	(7.35)	(26.94)
Change in No. of Senior Citizens in HH	185.444*	107.268	110.804	-32.564	32.569	-47.074
	(104.18)	(179.99)	(232.72)	(92.11)	(47.72)	(174.91)
Change in Female Head Status	219.067	-1,017.054*	-25332	-49.612	109.035	-540.245
	(340.62)	(588.48)	(760.89)	(301.17)	(156.01)	(571.87)
Change in Number of HH Members	35.717	181.948	65.19	-50.53	1415	139.699
	(67.76)	(117.06)	(151.36)	(59.91)	(31.03)	(1196)
Change in No. of HH Children	128.106	131.897	-30.431	-0.185	2.201	-51.773
	(128.39)	(221.81)	(286.80)	(1172)	(58.80)	(215.55)
Change in Livestock Value	-0.003	-0.021	-0.005	-0.008	0.002	-0.017
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Change in Dependency Ratio	-121.874	-105.934	-197.56	146.236	1.249	-256.25
	(151.76)	(262.19)	(339.00)	(134.18)	(69.51)	(254.79)
Change in ES Wage	50.032**	86.483**	35.955	12.935	12.126	21137
	(24.31)	(42.01)	(54.31)	(21.50)	(11.14)	(40.82)
Change in ES Transfers	-0.017	-0.033	-0.014	-0.002	0.009	-0.031
	(0.03)	(0.05)	(0.06)	(0.02)	(0.01)	(0.04)
Constant	171.401	-161.757	20.976	-60.699	42.013	-607.293**
	(168.81)	(291.65)	(377.09)	(149.26)	(77.32)	(2861)
Observations	181	181	181	181	181	181

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are in parentheses.
Children are defined as household members less than 16 years old. All results presented are second stage results.

Appendix 1. Lagrangean and first order conditions for case 3.

$$\mathcal{L} = U^M(C_1^M;Z)+U^F(C_1^F;Z)+\beta[U^M(C_2^M;Z)+U^F(C_2^F;Z)] -$$

$$\lambda_1\ (C_1^F + rK_1 - w_{usa}(1-N)T_1^M - C_1^M - f(R_1, K_0+K_1) - w_1M_1 - B_1) -$$

$$\lambda_2\ (C_2^F + rK_2 - w_{usa}(1-N)T_2^M + C_2^M - f(R_2, K_0+K_1+K_2) - w_2M_2 + (1+r)B_1) -$$

$$\mu_1(T_1 - R_1 - M_1) - \mu_2(T_2 - R_2 - M_2) \qquad \text{(A.1)}$$

The first order conditions for this problem are:

$$\mathcal{L}_c: \quad U'_{C_1^M} - \lambda_1 \le 0 \qquad \text{(A.2)}$$

$$\mathcal{L}_c: \quad U'_{C_1^F} - \lambda_1 \le 0 \qquad \text{(A.3)}$$

$$\mathcal{L}_c: \quad \beta U'_{C_2^M} - \lambda_2 \le 0 \qquad \text{(A.4)}$$

$$\mathcal{L}_c: \quad \beta U'_{C_2^F} - \lambda_2 \le 0 \qquad \text{(A.5)}$$

$$\mathcal{L}_{R1}: \quad \lambda_1 f'_{R_1} + \mu_1 \le 0 \qquad \text{(A.6)}$$

$$\mathcal{L}_{R2}: \quad \lambda_2 f'_{R_2} + \mu_2 \le 0 \qquad \text{(A.7)}$$

$$\mathcal{L}_{M1}: \quad \lambda_1 w_1 + \mu_1 \le 0 \qquad \text{(A.8)}$$

$$\mathcal{L}_{M1}: \quad \lambda_2 w_2 + \mu_2 \le 0 \qquad \text{(A.9)}$$

$$\mathcal{L}_{K1}: \quad \lambda_1(f'_{K_1^i} - r) + \lambda_2 f_{K_1} \le 0 \qquad \text{(A.10)}$$

$$\mathcal{L}_{K2}: \quad \lambda_2(f'_{K_2} - r) \le 0 \qquad \text{(A.11)}$$

$$\mathcal{L}_B: \quad \lambda_1 - \lambda_2(1+r) \le 0 \qquad \text{(A.12)}$$

$$\mathcal{L}_{\lambda 1}: \quad C_1^F + rK_1 - w_{usa}(1-N)T_1^M - C_1^M - f(R_1, K_0+K_1) - w_1M_1 - B_1 \le 0 \qquad \text{(A. 13)}$$

$$\mathcal{L}_{\lambda 2}: \quad C_2^F + rK_2 - w_{usa}(1-N)T_2^M + C_2^M - f(R_2, K_0+K_1+K_2) - w_2M_2 + (1+r)B_1 \qquad \text{(A.14)}$$

$\mathcal{L}_{\mu 1}$: $T_1^F - R_1^F - M_1^F \leq 0$ (A. 15)

$\mathcal{L}_{\mu 2}$: $T_2^F - R_2^F - M_2^F \leq 0$ (A. 16)