The Effects of Migration and Remittances on Productive Investment in Rural Mexico[1]

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Abstract

In this paper, we analyze the effects of migration and remittances on one measure of local economic development: investments in local productive activities. We develop a dynamic model of household decision making that includes migration, remittances, and local production. We complement our theoretical model with an empirical analysis of the relationships between migration, remittances and local production using data from the Mexico National Rural Household Survey. Our theoretical model suggests that activity participation decisions, production parameters, and consumption choices are the key factors that will determine investment, and the empirical results support that view. According to our empirical results, migrant remittances did not increase rural investment in agricultural production. Remittances from migrants working in other parts of Mexico were a deterrent to agricultural investment. PROCAMPO payments, education, and income from crop production increase farm investment. Regional or village level variables that relate to parameters of agricultural production functions are important in determining activity and investment decisions.

Keywords: migration, remittances, investment, Mexico, dynamic model
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1. Introduction

Many researchers have investigated the decision to migrate (see e.g., Sjaastad, 1962; Orrenius and Zavodny, 2005; Rojas Valdes, Lin Lawell and Taylor, 2016) and the effects of migration and remittances on economic development in migrant origin areas (see e.g., Singh et al., 1986; Adams, 1998; Stark, 1991; Adams, 1998; Rozelle, Taylor and deBrauw, 1999; Lopez-Feldman and Taylor, 2007; DeBrauw and Rozelle, 2008; Yang, 2008; Gibson, McKenzie and Stillman, 2010). However, the nature of the relationship between migration, remittances, and development seems to vary over time and space, and there are some notable cases where migration and remittances have been shown to have a neutral or even negative effect on some measures of economic development. In this paper, we analyze the effects of migration and remittances on one measure of local economic development: investments in local productive activities.

Migration and remittances have two possible effects on production in the sending area. First, the act of migration decreases the local quantity of labor. Depending on market closure scenarios, this may or may not be important. If there are thin labor markets, or even high costs of monitoring hired (as opposed to family) labor, then migration (with or without remittances) could move production to a more capital intensive input mix. We will call this the direct effect of migration on production, as labor becomes relatively more expensive. Second, remittances will increase income, and if there are any constraints to credit available for local production then remittance income will shift production toward a more cash-input intensive mix. We call this the indirect effect of remittances on production.

Disentangling the different effects is important for policy design. Suppose that migration and remittances lead to some measure of increased investment, and a policy maker wants to duplicate that without migration. One possibility may be to replicate migrant remittances by increasing access to credit. If the direct effect of migration is dominant on investment motivations, increased access to credit will not necessarily speed development. The investments made in the migration and remittances scenario may not be optimal unless the labor shortage also happens. With an improved credit market but the same labor market, labor saving investments may still be sub-optimal. In other words, the investment in that case may be the result of both migration and remittances. Replicating one of the factors, through credit access, may not be

enough to encourage investment. If the direct effect of remittances is dominant, credit access may replicate the investment effects of migration and remittances.

Migration effects and remittance effects also have different implications for price effects. Migration effects are not likely to lead directly to lower cost agricultural production, but remittance effects are more likely to do so. The importance of the price effects is largely distributional, but can be important in terms of social welfare.

One way to begin the job of disentangling these different effects is to compare the impacts of migrant remittances to the impacts of government programs that provide cash income to rural households. Depending on the conditions necessary for the governmental cash transfer, these programs may not have the same kind of substitution effect that migration can cause, but can still have the potential for relieving cash constraints. By comparing the impacts of migrant remittances on productive investments to the impacts of government cash transfers on productive investments, we can analyze the real effects on economic development that migration and remittances may have.

In this paper we address these issues by developing a dynamic model of household decision making that includes migration, remittances, and local production. This model affords several insights into the relationships between migration, remittances and local production. We use this model to frame the questions: Under what circumstances do migration and remittances affect investments in local production in the migrant sending area? How do those effects interact in and affect the local economy? And: How do the effects of migration and remittances compare to the effects of cash transfers that are not conditional on migration?

We complement our theoretical model with an empirical analysis of the relationships between migration, remittances and local production using data from the Mexico National Rural Household Survey (abbreviated as ENHRUM, by its Spanish acronym). In order to disentangle migration effects and remittance effects in our sample, we evaluate the possibility that migrant remittances release credit constraints by comparing their impacts to the impacts of other cash transfers. PROCAMPO agricultural support transfers and PROGRESA educational support transfers are the governmental programs that we use to make this comparison.

A dynamic model is important for realistically modeling migration-development relationships. Migration involves the "migration capital" that is accrued as individuals spend time learning about job markets and border crossings, and acquiring language skills and contacts

or social networks in their destination areas. The evolution of migration capital and the related migration networks is suggested as a cause of the dynamic effects that Stark, Taylor and Yitzakhi (1986) observe in their work. Using the appropriate type of model allows us to account for these factors, and to model the evolution of migration capital explicitly.

Capital goods issues are not the only factor that leads us to model migration and development relationships with a dynamic framework. Ties remain between migrants and the places that they leave for long periods, facilitated by family members that stay behind and at times by a desire on the part of migrants to eventually return to the sending area. Impacts work both ways: migration can impact development and development can impact migration. Theoretical work in the economics of migration has only touched on these subjects of long term connections and of multidirectional relationships. If we want to understand the nature of migration-development relationships, taking dynamic factors and feedback effects into account is very important.

The relationships between migration and development are the results of migration systems that are linked over long distances and with multiple feedbacks. An example of this kind of continual optimization can be drawn from the effect that a change in conditions in the migrant destination has on investment in local production in a remote rural area. The marginal product of capital is a determinant of the optimal capital use in production, and so of investment. The marginal product of capital depends on the wage rate and characteristics of labor that is available. Changes in migrant destination conditions will have an effect on labor market decisions made in the migrant sending area, and through that market on the cost and availability of labor for production. This effectively changes the optimal amount of capital applied to production for the sending households and in the sending region. For a household that receives remittances there is also a direct effect of remittances resulting from changes in the destination area that change optimal remittance decisions.

The feedback effects that are involved in migration and development relationships will vary over time and space. Dynamic modeling will help to account for the evolution over time, but in order to account for differences over space we also include regional characteristics in our model of migration and development relationships. The importance of regional differences has not received enough attention in studies of migration and development relationships. It is not clear how relevant comparisons are of different migration studies when the comparisons involve

different settings. To incorporate regional characteristics into our model, we evaluate which characteristics might be important, using our theoretical model, and incorporate variables that measure these characteristics in our empirical specification. By incorporating regional differences into our empirical analysis, we can address some of the questions that surround comparisons within the literature.

Our theoretical model suggests that activity participation decisions, production parameters, and consumption choices are the key factors that will determine investment, and the empirical results support that view. According to our empirical results, migrant remittances did not increase rural investment in agricultural production. Remittances from migrants working in other parts of Mexico were a deterrent to agricultural investment. Regional or village level variables that relate to parameters of agricultural production functions are important in determining activity and investment decisions.

Our paper proceeds as follows. In Section 2 we present our dynamic theory model. In Section 3 presents our empirical strategy. Section 4 describes our data. We present our empirical results in Section 5. We discuss and conclude in Section 6.

2. Model

We begin by presenting a simplified two-period model that illustrates several of the important points. We then present a more extensive continuous time optimal control model that allows for an open ended time frame and includes additional activities and inputs.

2.1. Two-period model

The basic form of our two-period model imagines a household with a central decision maker, who maximizes utility of consumption by choosing the labor assignments of household members. In this basic illustration, each member can work at home in a production process $f(.)$ that uses labor and capital; or can work in a distant labor market and earn wages according to the function μ(.). The household can also choose to decrease the person-hours dedicated to work and instead consume leisure *b*. Household person-hours is normalized to one, so effectively the household chooses a portion *H* to assign to the distant market, a portion *b* for leisure, and the remaining (1-*H*-*b*) for labor.

Per-period returns may be high in the distant market, but there is some cost that must be overcome to reach that market. This cost decreases with the size of the migration network, or the amount of 'migration capital' M_t that the household possesses at time *t*. For ease of illustration, we assume that there is no market for labor. That assumption will be relaxed in the next section.

Formally, the problem is:

$$\max_{H,c,I} \; U(c_1, b_1) + e^{-r} U(c_2, b_1) \tag{1}$$

s.t.

$$c_t = pf(1 - H_t, k_t) + \mu(H_t, M_t) - I_t$$
$$k_{t+1} = k_t + I_t$$
$$M_{t+1} = M_t + H_t,$$

where H_t denotes migrant labor at time *t*, c_t denotes consumption at time *t*, and I_t denotes investment at time *t*, b_t denotes leisure at time *t*, and k_t denotes capital at time *t*. Additionally, we assume that the household production function $f(.)$ is concave in both labor (1-H_t-b_t) and capital (k_t),and has a positive cross partial derivative. Migrant earnings are increasing in both labor (H_t) and migration capital (M_t).

Solving the model yields several first-order conditions. First, labor decisions equate the marginal benefits of each activity if an interior solution is reached. For example, the condition for the first period labor allocation is given by:

$$\frac{\partial \mu}{\partial H}(H_1, M) + e^{-r} \frac{\frac{\partial u}{\partial c}(c_2, b_2)}{\frac{\partial u}{\partial c}(c_1, b_1)} \frac{\partial \mu}{\partial M}(H_2, M_1 + H_1) = p \frac{\partial f}{\partial H}(1 - H_1 - b_1, k_1), \tag{2}$$

which sets the marginal benefits of migrating equal to the marginal benefits of working in the home production process. The left side of the equation represents the benefit, or what is gained by migrating in the first period (migrant earnings in that period plus the value of migration capital in the next period) and the right side represents the cost (decreased production).

There is a similar condition for the tradeoff between leisure and production:

$$\frac{\partial u}{\partial c}(c_1, b_1) p \frac{\partial f}{\partial H}(1 - H_1 - b_1, k_1) = \frac{\partial u}{\partial b}(c_1, b_1). \tag{3}$$

The condition in equation (3) also equates the marginal costs and marginal benefits, this time of consuming leisure.

The following condition, which equates the marginal benefits of leisure and of migration, must also hold:

$$\frac{\partial \mu}{\partial H}(H_1, M) + e^{-r}\frac{\frac{\partial u}{\partial c}(c_2, b_2)}{\frac{\partial u}{\partial c}(c_1, b_1)}\frac{\partial \mu}{\partial M}(H_2, M_1 + H_1) = \frac{\partial u}{\partial b}(c_1, b_1). \quad (4)$$

All of these conditions will be true for an interior solution, and for a partial corner solution that leads to the household participating in one activity and consuming leisure, one of them will be true. The last condition, equating marginal benefits from migration and from leisure, would hold in the outcome where migration and remittances lead to decreased economic activity locally and increased leisure consumption.

The first-order condition for investment given by:

$$e^{-r}p\frac{\partial f}{\partial k}(1 - H_2 - b_2, k_1 + I) = \frac{\frac{\partial u}{\partial c}(c_1, b_1)}{\frac{\partial u}{\partial c}(c_2, b_2)}. \quad (5)$$

In equation (5), we see that the gains from investment are set equal to the intertemporal rate of substitution, ensuring that the marginal unit of future production gained through investment is equal to the current value that a marginal unit of consumption would represent. Another way to say that is that investment is made so that marginal future benefits of investment are equal to marginal current costs of investment. Investment is made to equate the marginal loss in utility from period one consumption with the discounted gain from increased production in period two. Investment depends on household preferences (through both the discount rate and the shape of the utility function), the productivity of capital, the starting amount of capital, and the household's future optimal labor assignment.

The final first-order condition governs the optimal values for labor and leisure in the second period:

$$p\frac{\partial f}{\partial H}(1 - H_2 - b_2, k_1 + I) = \frac{\partial \mu}{\partial H}(H_2, M_1 + H_1) \quad (6)$$

$$\frac{\partial u}{\partial c}(c_2, b_2)p\frac{\partial f}{\partial H}(1 - H_2 - b_2, k_2) = \frac{\partial u}{\partial b}(c_2, b_2) \quad (7)$$

$$\frac{\partial \mu}{\partial H}(H_2, M_1 + H_1) = \frac{\partial u}{\partial b}(c_2, b_2). \quad (8)$$

In other words, marginal benefits from any two activities are set equal to each other in the second period.

If the household assigns some of its labor to migration in the first period, migration will be even more beneficial in the second period due to the increased level of migration capital. Without investment, this implies that the level of labor assigned to the at-home activity will likely decrease. Even with investment, there is no guarantee that labor dedicated to the at-home

activity will increase or even remain steady. In other words, in this model investment is a necessary but not sufficient condition to increase economic activity in the area of origin.

When the household chooses to migrate, it has the opportunity to build two different types of capital. Migration capital is increased automatically by the act of migrating. Productive capital can be increased in the future if some consumption is foregone. The relative advantages of building these two types of capital will determine whether economic activity in the origin area increases or decreases. The model illustrates two basic possibilities that can result from migration: migrant earnings can boost investment and lead to increased production in the sending area, or migration can become the dominant activity, as costs of migration decrease (or benefits increase) for each new set of migrants. The actual outcome depends on the shapes of the production function and the migrant earnings function. To the extent that either of these may vary from place to place, the regional characteristics that determine them can affect the investments induced by migrant remittances.

Migration capital is less concrete than productive capital. It can include, for example, knowledge of the job market in the destination area, ability to speak the language that is predominant in that area, and knowledge of crossing into the area. Both the value of productive capital in the home area and the way that migration capital accumulates are likely to differ across different migration scenarios. The different scenarios make an important difference in whether or not migration and remittances lead to productive investments in a given region.

2.2. Continuous time model with additional activities and with transfer payment

We now present a more extensive continuous time optimal control model that allows for an open ended time frame and includes additional activities and inputs. The optimal control model that follows considers a similar household to the one above, but adds a wage labor market and a transfer payment for the home production activity to the household's setting. In this section, we add subscripts to labor H for the different activities (f for at-home production, g for wage work, m for migration), and incorporate leisure b in the household choice set. The at-home production function is transformed to also include land (L), which will be a subset of capital so that the function argument is $k+L$; and a purchased input d, which could represent, for example, fertilizer or hired labor. In the case where it represents hired labor, we are assuming that hired labor is not necessarily a perfect substitute for family labor. The price of d is w. The additional

income possibilities are represented by $g(.)$ for wage work and θ(.) for the government transfer.

The household utility in period *t* is a function of consumption and leisure:

$$U_t = u(c_t, b_t). \tag{9}$$

The household's decisions are subject to a budget constraint in every period:

$$pc + wd \leq pf\left(H_f, k + L, d\right) + g\left(H_g\right) + \mu(H_m, M) + \theta\left(L, H_f\right) - I. \tag{10}$$

Home production of consumables is a function of capital, land, purchased inputs, and labor; wages earned in the labor market are a function of labor dedicated to that market. Migrant remittances are a function of migrants sent out of the household and migration related networks and capital (*M*). Payments from the agricultural support program are determined by land registered in the program (*L*) as well as household participation in some kind of farm activity. The payments are assumed to be linear in land as long as participation in the at-home production activity is non-zero. For the sections below that deal with an interior solution to the problem, the partial derivative of θ with respect to H_f will be left out as it will be equal to zero in all strict interior solutions.

The equation of motion of capital is given by:

$$\dot{k} = I\ . \tag{11}$$

The equation of motion for the migrant capital or networks is a function of current migration and current migration networks:

$$\dot{M} = \dot{M}(H_m, M)\ , \tag{12}$$

where the shape of this function is such that it is quasi-concave in H_m.

Household time is split between home production H_f, wage work H_g and migration H_m, up to the total allotment $\overline{H}$:

$$H_f + H_g + H_m + b \leq \overline{H}\ . \tag{13}$$

The household maximizes the discounted stream of utility subject to the budget constraint, the equations of motion and the constraint on maximum time allotment in each period. Choice variables for the maximization are investment and time allotment into the four different activities.

The optimal control problem faced by the household is therefore given by:

$$\max_{\{H_f, H_g, H_m, b, d, I\}} \int_{t=0}^{T} u(c_t, b_t)\, e^{-rt} dt \tag{14}$$

s.t.

$$pc + wd \leq pf\big(H_f, k + L, d\big) + g\big(H_g\big) + \mu(H_m, M) + \theta\big(L, H_f\big) - I$$
$$\dot{k} = I \qquad : \lambda_1$$
$$\dot{M} = \dot{M}(H_m, M) \qquad : \lambda_2$$
$$H_f + H_g + H_m + b \leq \bar{H},$$

where λ_1 and λ_2 are multipliers for the equations of motion for physical capital and migration capital, respectively.

We can write the current-value Hamiltonian:

$$\eta = u(c, b) + \lambda_1 I + \lambda_2 \dot{M}, \tag{15}$$

where the control variables are home production H_f, wage work H_g, migration H_m, leisure b, purchased input d, and investment I, and where, after substituting out wage work H_g, we can write consumption c as:

$$c = f\big(k + L, H_f, d\big) + \frac{1}{p}\big[g\big(\bar{H} - H_f - H_m - b\big) + \mu(H_m, M) + \theta\big(L, H_f\big) - I - wd\big]. \tag{16}$$

The solution to this problem is governed by a set of Pontryagin first-order conditions. The first-order condition with respect to home production H_f is given by:

$$\frac{\partial f}{\partial H_f} - \frac{1}{p}\frac{\partial g}{\partial H_g} = 0\ , \tag{17}$$

which is fairly simple, and serves as a reminder that the marginal value of labor in each activity will be equal for a household that exhibits an interior solution.

The first order condition for migration H_m returns something slightly more complicated:

$$\frac{\frac{\partial u}{\partial c}}{p}\left(-\frac{\partial g}{\partial H_g} + \frac{\partial \mu}{\partial H_m}\right) + \lambda_2 \frac{\partial \dot{M}}{\partial H_m} = 0. \tag{18}$$

The condition in equation (18) reveals the tradeoffs being made in the migration decision. The first term represents the costs of the current period tradeoff in marginal utility terms, and the second term represents the value of the increased migration capital being carried forward. An interesting point to note here is that if migrant destination area net earnings per unit of labor are higher than earnings per unit in the wage market (or, if the first term is positive) then the shadow value of increasing migration capital must be negative. This is a purely mechanical result, but can be interpreted as saying that if the household exhibits an interior solution to the problem while there are high migrant wages, then there must be some other cost related to migration that prevents the whole household from participating in that labor market.

The decision for leisure is relatively straightforward, and equates the marginal rate of substitution to the price ratio:

$$\frac{\frac{\partial u}{\partial b}}{\frac{\partial u}{\partial c}} = \frac{\frac{\partial g}{\partial H_g}}{p}. \tag{19}$$

If the marginal earnings of dedicating another unit of labor to wage income are a constant and price of consumption is also a constant, then increases in consumption must be accompanied by increases in leisure. In other words, for a village with a constant wage rate and exogenous prices, remittances that increase consumption should be expected to increase leisure.

Use of the purchased input is determined by setting the marginal value product equal to the price of the final good:

$$p\frac{\partial f}{\partial d} = w. \tag{20}$$

There is also a simple condition that governs optimal investment, saying that the marginal utility of consumption now is equal in cost to the shadow value of investment:

$$-\frac{\frac{\partial u}{\partial c}}{p} + \lambda_1 = 0. \tag{21}$$

The first-order conditions relating to the state variables yield the following results:

$$-\frac{\partial u}{\partial c}\frac{\partial f}{\partial k} = \dot{\lambda_1} - r\lambda_1, \tag{22}$$

$$-\left(\frac{\frac{\partial u}{\partial c}}{p}\frac{\partial \mu}{\partial M} + \lambda_2\frac{\partial \dot{M}}{\partial M}\right) = \dot{\lambda_2} - r\lambda_2 \ . \tag{23}$$

Solving for the multipliers in equations (21) and (18), we derive the following respective relationships:

$$\lambda_1 = \frac{\frac{\partial u}{\partial c}}{p}, \tag{24}$$

$$\lambda_2 = \frac{\frac{\frac{\partial u}{\partial c}}{p}\left(\frac{\partial g}{\partial H_g} - \frac{\partial \mu}{\partial H_m}\right)}{\frac{\partial \dot{M}}{\partial H_m}}. \tag{25}$$

Equation (24) for λ_1 shows that the marginal utility of income is equal to the shadow value on investment. Equation (25) for λ_2 is analogous, with the appropriate transformation for difference between local wages and migrants earnings, and accounting for the value of migration capital.

Substituting equations (24) and (25) for the multipliers into equations (22) and (23) respectively, we show that the multipliers evolve according to the following rules:

$$\dot{\lambda_1} = \frac{\partial u}{\partial c}\left(-\frac{\partial f}{\partial k} + \frac{r}{p}\right), \tag{26}$$

$$\dot{\lambda_2} = \frac{\frac{\partial u}{\partial c}}{p}\left[-\frac{\partial \mu}{\partial M} + \left(r - \frac{\partial \dot{M}}{\partial M}\right)\frac{\left(\frac{\partial g}{\partial H_g} - \frac{\partial \mu}{\partial H_m}\right)}{\frac{\partial \dot{M}}{\partial H_m}}\right]. \tag{27}$$

We can differentiate λ_1 with respect to time and set it equal to $\dot{\lambda_1}$ to look at the evolution of consumption with respect to time:

$$\dot{c} = \frac{\frac{\partial u}{\partial c}}{\frac{\partial^2 u}{\partial c^2}}\left[r - p\frac{\partial f}{\partial k}\left(k, L, H_f, d\right)\right]. \tag{28}$$

Since the first term on the right-hand side of equation (28) will be negative for reasonable forms of utility functions, the above equation of motion for consumption tells us that consumption will be increasing as long as the marginal value product of capital is greater than the discount rate. The discount rate decreases the value of a dollar of consumption in the future compared to consumption now. The marginal value product of capital allows that dollar to become more than a dollar's worth of production. As long as the potential increase seen by investing in production in the future is greater than the loss in value from postponed consumption, then investment takes place. Investment enables household production, and therefore consumption, to increase in the future. If the opposite occurs, and capital is relatively unproductive in the at home production activity, then consumption will be high in the current period because of capital draw down (investment will be negative) and decreasing going forward, as the possibility for draw down evaporates.

The possibility for a household steady-state is apparent from the condition $\dot{c} = 0$. When the bracketed term in equation (28) is equal to zero, household consumption will be steady. Reaching the steady state for consumption also necessitates that the household labor assignments are fixed. Changes to labor assignments may change the marginal product of capital, and therefore the relationship between the marginal value product of capital and the discount rate, throwing the household out of the steady state.

A similar expression can be drawn from the other multiplier λ_2:

$$\dot{c} = \frac{\frac{\partial u}{\partial c}}{\frac{\partial^2 u}{\partial c^2}}\left[\frac{\left(r - \frac{\partial \dot{M}}{\partial M}\right)}{\frac{\partial \dot{M}}{\partial H_m}} + \frac{\partial^2 \dot{M}}{\partial H_m^2}\dot{H_m} - \frac{\frac{\partial \mu}{\partial M}\left(\frac{\partial \dot{M}}{\partial H_m}\right)^2 + \frac{\partial^2 g}{\partial H_g^2}\dot{H_g} + \frac{\partial^2 \mu}{\partial H_m^2}\dot{H_m}}{\frac{\partial g}{\partial H_g} - \frac{\partial \mu}{\partial H_m}}\right]. \tag{29}$$

Again the condition in equation (29) shows that changes in consumption are related to the relationship between the discount rate and the marginal returns to accruing capital, in this case

migration related capital. However, it can be seen that the marginal returns to increasing migration capital are actually complicated and not that straightforward to interpret.

Both of the $\dot{c}$ conditions in equations (28) and (29) are differential equations, to which some techniques may be applied. The first observation we make here is that we are more directly interested in investment than in consumption, so we will use the definition of $\dot{c}$ to substitute an expression in that includes investment:

$$\dot{c} = \frac{\partial f}{\partial k} I + \frac{\partial f}{\partial H}\dot{H}_f + \frac{\partial f}{\partial d}\dot{d} + \frac{1}{p}\left[\frac{\partial g}{\partial H_g}\dot{H}_g + \frac{\partial \mu}{\partial H}\dot{H}_m + \frac{\partial \mu}{\partial M}\dot{M} + \frac{\partial \theta}{\partial H}\dot{H}_f - \dot{I} - w\dot{d}\right], \qquad (30)$$

We can rearrange to look at home production investments:

$$I\left(-\frac{\partial f}{\partial k}\right) + \frac{1}{p}\dot{I} = \dot{H}_f\left(\frac{\partial f}{\partial H_f}\right) + \frac{\partial f}{\partial d}\dot{d} + \frac{1}{p}\frac{\partial g}{\partial H_g}\dot{H}_g + \frac{1}{p}\frac{\partial \mu}{\partial H_m}\dot{H}_M + \frac{1}{p}\frac{\partial \mu}{\partial M}\dot{M} - \frac{w}{p}\dot{d} - \dot{c}\,. \qquad (31)$$

Using an integrating factor gives a form of the solution for *I*:

$$I(t) = \frac{A}{e^{\int^t -\frac{\partial f}{\partial k} p\, ds}} + \frac{1}{e^{\int^t -\frac{\partial f}{\partial k} p\, ds}} \int^t \left[p\dot{H}_f\left(\frac{\partial f}{\partial H_f}\right) + p\frac{\partial f}{\partial d}\dot{d} + \frac{\partial g}{\partial H_g}\dot{H}_g + \frac{\partial \mu}{\partial H_m}\dot{H}_M + \frac{\partial \mu}{\partial M}\dot{M} - w\dot{d} - p\dot{c}\right] e^{\int^s -\frac{\partial f}{\partial k} p\, du \int} \quad ds, \qquad (32)$$

where *A* is a constant of integration. To delve further into this, we can look at some of the terms on the right-hand side independently and sign them, at times conditionally.

There are a few basic, inter-related questions to examine in equation (32) for investment that relate to the primary purpose of this paper. The relationships between migration, remittances, and investment are central to this paper. This expression for investment offers an opportunity to ask: What happens to investment as migration increases or decreases? And related to this: When is investment negative? As well as: What factors can be important in determining the magnitude of investment?

There are a handful of terms in equation (32) that can be negative, probably the most important of which relates to consumption. Whenever consumption is increasing, this puts negative pressure on investment. A large enough increase in consumption will push investment to be negative. Another way to look at that observation would be to say that drawing down capital, or exhibiting negative investment, is likely to lead to increasing consumption for some period of time. The other terms that can be negative relate to the latter question, about how changes in investments in migration are related to investment in productive capital.

The effect on productive investment of increasing migration and migration capital is similar to the effect of consumption changes. The direct effect of increasing migration acts

through the term: $\dot{H_m}\left(\frac{\partial \mu}{\partial H_m} - \frac{\partial g}{\partial H_g}\right)$. This is the difference between net additional earnings per migrant and wages, and so is not expected to be negative, except perhaps at very early stages of migration. The stock effect of migration is captured in the term $\frac{\partial \mu}{\partial M}\dot{M}$ and reminds us that increasing migration capital should increase total earnings of migrants and therefore allow for greater levels of investment, when using those earnings for investment is optimal. Increased amounts of migration capital will also make further migration more lucrative. If conditions for productive investment at home do not materialize, migration can become the primary economic activity.

Another important fact about the investment expression is that all of it is scaled by the marginal product of capital in home production. A low value for this cannot make investment negative, but can make it negligible. High values of marginal productivity can make investment large even if other conditions exert downward pressure. In other words, the expression above can be analyzed for impacts on investment in many ways, but the actual potential gain from investment (embodied by the marginal product of capital in productive activities) is an important factor in determining optimal levels of investment. The role of productivity also feeds in through the purchased input and through household labor decisions in home production.

There is also an indirect effect on investment through changes in consumption. Referring back equation (28) for $\dot{c}$, we can expect that consumption is increasing when the marginal value product of capital is greater than the discount rate. When there is room to make worthwhile investments, the increase in income that results from those investments is split between increased consumption and further investment. Another fact that we can see from the above derivation relates to the absence of θ. This is because we are assuming that the farm support program does not change over time. The other transfers affect investment because they do change over time, through changes in household resource allocation. We can say, then, that according to this model the farm support program should not affect the investment path, though the initial levels of investment may be related to the farm support program in some way.

2.3. The effects of government programs and migrant remittances

There are two sources of income that can be thought of as transfer payments that factor into the household's budget and decision making in the model. The first, a government transfer, comes from a public source. The second, migrant remittances, comes from a private source.

The public source is an agricultural support program. Agricultural support programs are started for many different reasons, but tend to be something that persists beyond those intended reasons. Mexico's PROCMAPO program was originally meant to help compensate farmers for the ending of price supports that was necessary for Mexico's inclusion in the North American Free Trade Agreement. It has persisted long past its intended purpose. Like many farm support programs, its future is uncertain. In some ways PROCAMPO is as straightforward as the cash transfer program. Qualifications for the program are clear and based on past behavior. In order to keep receiving the payments, households must keep the land in "productive use".

Households in the model allocate time to home production so that the following rule is satisfied:

$$p\frac{\partial f}{\partial H_f}(H_f) + \frac{\partial \theta}{\partial H_f}(H_f) = \frac{\partial g}{\partial H_g}(H_g). \tag{33}$$

The important thing here is to think about what the second term on the left-hand side means, and how that function is shaped. In the case of PROCAMPO, the household receives a payment corresponding to the amount of registered land that it holds as long as that land is in productive use. In the model, we can represent this by:

$$\theta(L, H_f) = \theta L \;\; if \; H_f \geq F$$
$$\theta(L, H_f) = 0 \; otherwise, \tag{34}$$

where F represents the minimum amount of labor required to keep the land in nominal productive use. If we allow for different households to experience different marginal productivity levels, we can again set up a spectrum of different household types. For some households home production will always be more advantageous than wage labor. These households will exhibit marginal productivities such that the following condition will hold:

$$p\frac{\partial f}{\partial H_f}(H_f) > \frac{\partial g}{\partial H_g}(H_g) \; \forall \; H_f, H_g \in [0, \bar{H}] \; . \tag{35}$$

These households will not participate in the wage labor market. Other households will find a natural equilibrium point where:

$$p\frac{\partial f}{\partial H_f}(H_f) = \frac{\partial g}{\partial H_g}(H_g)\,, for\ some\ H_f > F\ , \tag{36}$$

and will participate in both activities. The nature of the policy becomes important for the third group of households. These households would exhibit a natural corner solution, avoiding home production, due to a relationship between marginal productivities such that the following condition holds:

$$p\frac{\partial f}{\partial H_f}(H_f) < \frac{\partial g}{\partial H_g}(H_g)\ \forall\ H_f, H_g \in [0, \bar{H}]\ . \tag{37}$$

In this case, the policy can come into play. The relevant comparison involves production at the minimum level plus the payment versus no production at all. For a simple example, if wages are a linear function of time dedicated to the wage market (so that $g(H_g) = wH_g$) then the comparison becomes:

$$pf(k, L, F, d) + \theta(F) \gtrless \omega F. \tag{38}$$

Because there is a discontinuous change in earnings from home production at $H_f = F$, this is not a marginal comparison. Instead, it is just a comparison between the amount of income earned by minimal farm work and program participation and the income that would be earned in the wage labor market otherwise. If the policy payment is large enough, households that would otherwise leave home production will remain involved in that activity. A functioning land market may alleviate this issue, if the entitlement is transferable or the policy written to allow renting out land without loss of the entitlement.

Another subject that can be examined here is that of policy renewal or change. Land registered in the PROCAMPO program can be used for any productive purpose. However, inclusion in the program was originally contingent on having planted one of the crops that was part of the old agricultural support policies in a previous year. In other words, the agriculture ministry came around in 1994, and asked what crops farmers had planted in 1993. Any land that had been used for corn, beans or a few other important staple crops was enrolled into the PROCAMPO program and the farmer received payments each year based on the acreage of PROCAMPO land that he or she owned. Under some stringent conditions, such payment would not have any impact on crop choice. However, crop choice and other decisions would be affected if farmers believe that a future re-evaluation of eligibility or program rules may take place. Farmers may plant corn or beans or other programs crops based on a belief that the agriculture ministry may come around again and recount land to evaluate continued inclusion in the

program. In this case, the decision to switch from a program staple crop to a cash crop is dependent on the program payment and difference in expected profits.

To account for this in the model, we need to introduce another state variable, a corresponding control variable, and change the home production function and the relevant transfer function slightly. Calling our control variable q choice of crop, we say that the corresponding state variable Q is equal to 1 if q in the last period was a program crop (q_p) and equal to zero when/if the household switches to a cash crop (q_c), and we can call the time at which this switch occurs $\tilde{t}$. The production function becomes:

$$f = f\big(k, L, H_f, q, d\big), \tag{39}$$

and the transfer becomes:

$$\theta = \theta\big(Q, L, H_f\big) = Q\theta\big(L, H_f\big) \ . \tag{40}$$

The equation of motion for the new state variable can be written as:

$$\begin{aligned} \frac{dQ_t}{dt} &= -1 \ if \ t = \tilde{t} \\ &= 0 \ otherwise. \end{aligned} \tag{41}$$

So then our Hamiltonian becomes:

$$\eta = u(c) + \lambda_1 I + + \lambda_2 \dot{M} + \lambda_3 \frac{dQ_t}{dt} - \gamma\big(H_f + H_g + H_m - \overline{H}\big) \ , \tag{42}$$

and consumption in this case is given by:

$$c = f\big(k, L, H_{f,} q\big) + \frac{1}{p}\big[g\big(H_g\big) + \mu(H_m, M) + \theta\big(Q, L, H_f\big) + -I\big]. \tag{43}$$

The new parts of the problem are not continuous, so the normal analysis has to be adapted a bit. The decision about which crops to plant will be based on a comparison between the marginal value product of switching crops and the shadow value of staying in the program. In other words, if $u'(c)\Big(f(q_c) - f\big(q_p\big)\Big) > \lambda_3$ then the household will switch crops. If the opposite relation holds true, and the value of staying in the program is greater than the value of switching crops, the household will continue to plant the program staple crops.

The existence of the program introduces a discontinuous point in the returns to farming. Under this scenario, we should not expect that the marginal returns to labor in farming would be equal to the marginal returns to labor in any other activity. Empirical studies have shown that farmers in rural Mexico do not always equate the value of marginal product of labor to the wage. For example, examining the some of the same data used in this thesis, Arslan and Taylor (2009)

show that this is true and suggest that it is representative of different valuations of the native varieties of corn grown in these rural areas. Here we can posit another possible explanation: farmers may work on their relatively unproductive farms just enough so that (in their perception) they will still qualify for the PROCAMPO program should reevaluation occur in the coming year.

Farmers who make a decision based on a labor constraint like the one proposed above would choose a different level of self-employed crop labor than another other similar household that was not eligible for the program. Because the choice of labor allocation impacts the optimal level of capital and investment, these households may exhibit different investment behavior than other households as well.

In contrast to the public program, migration and remittance income "eligibility" is subject only to the household optimization laid out above. Who chooses to migrate will be based on the costs and benefits of doing so. Migration eligibility can be thought of as being determined by regional income possibilities in both the origin and destination areas, along with household preferences and parameters.

The key factors that we want to examine with our model are the effects of migrant remittances and the government transfer program on investment in productive capital. An important takeaway from the above analysis is that any income to the household can impact investment through changes in consumption or productivity. Investment is determined by the production process, and the evolution of the stream of consumption. The production process determines the optimal amount of capital to reach, and the changes in consumption over time determine the optimal rate at which to acquire capital.

Changes in productivity can also relate to cash income allowing the household to switch to a different production technology. In that case, the household would exhibit a new optimal point of capital, and would experience corresponding changes in labor allocation and consumption. This could be true for any type of cash income, but it may not be a smooth effect. There may be some level of payment or income necessary to switch technologies.

Households that specialize in wage work do not receive migrant remittances or the government transfer. There will therefore be no direct impact on these households of changes in payments. Indirect effects, through changes in the perception or expectation of earnings in migrant work or home production are possible.

For households that specialize in home production and receive the transfer payment, the expression for investment is strictly a function of the production technology, prices, household labor decisions and consumption. The transfer payment may impact labor decisions and consumption. If the transfer increases labor participation, that will increase the optimal amount of capital and will put upward pressure on investment. If the transfer decreases labor participation, the opposite effect will prevail.

Households that specialize in migration do not receive the government transfer. They may receive remittances. Remittance income can change the rate of investment by changing the stream of consumption, and the rate of growth of consumption.

For households that participate in two or all activities, any of the effects above can happen. The real avenues for transfers to impact investment will still be through the changes in consumption and labor participation or allocation.

3. Empirical Strategy

We develop an empirical model to measure the effects of income from transfers and other sources on investment. In order to analyze the different stages of decisions that make up the relationships of interest, we estimate the model in several steps.

We first model the household's choice of which income generating activity to participate in and the income generated from each activity. The set of income generating activities j includes agricultural home production (h), wage work (g), migration within Mexico (m_M) and migration to the U.S. (m_U). The income generated from each activity is censored by sample selection. A positive income from activity j is observed only when the household chooses to participate in activity j. Thus, the sample of those engaging in activity j is non-random, drawn from a wider population of households. Both the participation decision and the income generation must be modeled to avoid sample selection bias. Income y_{it}^j generated by activity j by each household i in each time period t can be estimated as:

$$q_{it}^j = F_q(x_{it}^h, x_{it}^g, x_{it}^{m_M}, x_{it}^{m_U}, x_{it}^y), \quad j = h, g, m_M, m_U \tag{44}$$

$$y_{it}^j = F_y^j(x_{it}^j, x_{it}^y, IMR^j), \quad j = h, g, m_M, m_U, \tag{45}$$

where q_{it}^{j} represents the decision to participate in activity j; y_{it}^{j} is the income generated from activity j and is observed only when $q_{it}^{j} > 0$; x_{it}^{h} are variables related to home agricultural production, including share of village land with good soil, share of village land that is held with secure property rights, share of village land that is irrigated, household farm asset value, household herd value, household land holdings, and household land holdings registered in the PROCAMPO program; x_{it}^{g} are variables related to wage work, including median wage in village and household experience in wage work; $x_{it}^{m_M}$ are variables related to migration within Mexico, including GDP growth in potential Mexico destination state, experience migrating within Mexico, and whether the indigenous language is spoken in the household; $x_{it}^{m_U}$ are variables related to migration to the U.S., including GDP growth in potential U.S. destination state, unemployment rate in potential U.S. destination state, experience migration to the U.S., and share of local households with a member working in the U.S., and; and x_{it}^{y} are variables related to multiple income-generating activities, including number of adults in household with primary education, and number of adults in household with secondary education.[2]

We estimate equations (44) and (45) for each activity using a Heckman selection model (Heckman, 1978). In the first step, probit regressions corresponding to the activity participation equations (44) are estimated, measuring the effect of the explanatory variables on the decision to participate in activity j. Inverse Mills ratios (IMR^{j}) are calculated for each activity. In the second step, the inverse Mills ratios are included as explanatory variables in the income equations corresponding to equation (45).

To account for the simultaneous nature of these decisions, the entire set of variables and controls $(x_{it}^{h}, x_{it}^{g}, x_{it}^{m_M}, x_{it}^{m_U}, x_{it})$ is included in each probit activity participation regression.

Parameters in selection models are estimated with more precision if some regressors in the selection equation can be excluded from the outcome equation (Wooldridge, 2002). To estimate the coefficients in the income equations (45) with more precision, we exclude the variables x_{it}^{k} related to all other activities k from the income equation (45) for activity j but not from the activity participation equation (44). Variables related to other activities are likely to

[2] As several of our regressors are time invariant, including share of village land with good soil and household land holdings, and as we are interested in the coefficients on many of these time-invariant regressors, we are unable to include household fixed effects in our regressions.

affect a household's activity choice decisions but, conditional on the activity choices, the income generated from an activity chosen arguably is not affected by variables related to other activities.[3]

We next model the household's decision to make investments. To acknowledge that there are different types of investments possible, we examine two types of investments *v*: farm investment (h_f) and livestock investment (h_l).[4] Farm investment includes investment in capital for home crop production. For most households, livestock is not a primary income generating activity. Investment in livestock is likely to be driven by factors different from those driving investment in crop production.

We divide agricultural investment into farm investment and livestock investment because the nature of livestock is much different than that of other capital investments. It also allows us to compare the impacts transfer payments on activities that are and are not connected with the original criteria that determined eligibility for those payments.

The amount of investment in each type of investment is censored by sample selection. A positive investment in investment type *v* is observed only when the household chooses to invest in investment type *v*. Thus, the sample of those investing in investment type *v* is non-random, drawn from a wider population of households. Both the decision to invest and the investment level must be modeled to avoid sample selection bias. Investment I_{it}^{v} in investment type *v* by each household *i* in each time period *t* can be estimated as:

$$s_{it}^{v} = F_s(x_{it}^{I}, x_{it}^{s}, \hat{y}_{i,t-1}^{h}, \hat{y}_{i,t-1}^{g} \hat{y}_{i,t-1}^{m_M} \hat{y}_{i,t-1}^{m_U}), \quad v = h_f, h_l \tag{46}$$

$$I_{it}^{v} = F_I^{j}(x_{it}^{I}, \hat{y}_{i,t-1}^{h}, \hat{y}_{i,t-1}^{g} \hat{y}_{i,t-1}^{m_M} \hat{y}_{i,t-1}^{m_U}, IMR^{v}), \quad v = h_f, h_l, \tag{47}$$

where s_{it}^{v} represents the decision to invest in investment type *v*; I_{it}^{v} is the investment level in investment type *v* and is observed only when $s_{it}^{v} > 0$; x_{it}^{I} are variables that affect both the decision to invest and the investment level, including Progresa transfers, PROCAMPO transfers, whether there are agricultural troubles at the household level, and household characteristics and

[3] Even though excluding variables from the income regressions improves the efficiency of our estimators, this exclusion restriction is not necessary for identification (Wooldridge, 2002).

[4] We focus on productive investments in rural Mexico. Data that we are using suggested that the productive value of capital in home owned businesses is uncertain. Looking across the panel, the households who own their own business seems to vary from survey year to survey year. For these reasons, we concluded that investment in a home owned business is a highly risky endeavor in rural Mexico, and may not fall into the category of investment that we are hoping to measure. We exclude the investments made in home owned businesses because of the risky nature.

village characteristics that affect both the decision to invest and the investment level; x_{it}^{s} are variables that affect the decision to invest but not the investment level, for which we use whether there are agricultural troubles in the village; and, for each activity j, $\hat{y}_{i,t-1}^{j}$ is the lagged predicted income level for activity j estimated in equation (45) above.

We estimate equations (46) and (47) for each activity using a Heckman selection model (Heckman, 1978). In the first step, probit regressions corresponding to the investment participation equations (46) are estimated, measuring the effect of the explanatory variables on the decision to invest in investment type v. Inverse Mills ratios (IMR^{v}) are calculated for each investment type. In the second step, the inverse Mills ratios are included as explanatory variables in the investment equations corresponding to equation (47).

To estimate the coefficients in the investment equations (47) with more precision, we exclude the variables x_{it}^{s} from the investment equation (47) for activity j but not the investment participation equation (46). For x_{it}^{s}, we use a dummy for whether there are agricultural troubles in the village, which is likely to affect a household's investment choice decisions but, conditional on the investment choices, arguably does not affect the investment level decision. Sources of agricultural troubles in the village include low rainfall or frost. We control for agricultural troubles at the household level in both the investment participation decision equation (46) and the investment level equation (47).

We control for Progresa transfers and PROCAMPO transfers in both the investment participation decision equation (46) and the investment level equation (47). The transfer payments allow us to make a comparison between different types or sources of income. While it is reasonable to expect income to be fungible to some extent, in practice different sources of income can have different effects on household consumption and investment. Perceptions of how permanent or transitory a given stream of income is may cause it to play a different role in asset accumulation or divestment. For example, Carter and Lybbert (2012) find different impacts on rural household asset and consumption smoothing for permanent versus transitory income.

The relationships between public and private transfers may be dependent on the motivation of and qualification for the transfers. For example, Amuedo-Dorantes and Juarez (2015) find that public transfers to the elderly in rural Mexico partially crowd out private transfers. They hypothesize that the motivation for the private transfers was altruistic (a la

Becker, 1974), in order to preserve the well-being of the elder person. The public transfer raises the welfare level of the recipient, who then requires less help from those who would offer private transfers. Strategic transfers are less likely to be crowded out (Bernheim, Shleifer and Summers, 1985).

Transfers from migrants meant to be used for farm investment could be strategic or altruistic. The presence of the public transfer programs may alter the use of migrant remittances. Our results cannot answer the question of what impact migrant remittances would have if there were no such public transfers. They do examine the impact of marginal changes in both the private and public transfers on rural productive investment.

4. Data

The data we use comes from the Mexico National Rural Household Survey (abbreviated as ENHRUM, by its Spanish acronym), which consists of a matched panel of 845 households in 11 states in four different regions of rural Mexico over the period 1980 to 2010 created from surveys conducted in 2002, 2007 and 2010.[5] These data contain the information necessary to construct an income profile, including labor, capital and inputs used in production, wages from local work, migrant remittances, and government transfer payments. The data also contain records, obtained through recall questions, of labor assignments for all household members dating back to the 1980s, reporting if the individual worked locally, and if so in what sector, if they worked in other parts of Mexico, and if they worked in the USA, for each year dating back to their first work experience or as far back as 1980. This gives us the ability to construct complete models of local household production in addition to migration, labor market, and investment decisions over the study period.

To quantify investments, the data contain comprehensive information on types of capital owned, approximate value currently or when purchased, and year purchased. We use this information to deflate the value of capital to the relevant period for each household-survey round observation.

[5] The survey instrument itself was largely unchanged, with the exception of adding and removing some parts each round for specific targeted research. We do not use any of the sections that are not present in all three rounds. In some cases, questions were simplified or data collection structured differently after the first round, in order to facilitate time savings.

The ENHRUM allows us to use data on households from many different regions, and to evaluate how some of the differences between those regions have an effect on migration and investment decisions, as well as on other labor allocations and income activities. Characteristics like types and methods of agricultural production, proximity to cities, and median incomes within a village vary greatly across the sample. The surveys contain detailed information about each of the households and each of the villages that households were drawn from. This allows for the kind of within sample variation that is necessary to test the importance of regional characteristics. In conjunction with our modeling approach, the ENHRUM data allow us to test all of the relationships that we are interested in.

Summary statistics for the data are given in Table 1. The summary statistics gives some insight into the composition of households in rural Mexico. Individuals with primary and/or secondary education are not uncommon in rural Mexico. The variable for primary education means that an individual did not go on to complete secondary education, so that the primary and secondary categories are mutually exclusive. On average, households hold about 5.56 hectares of land, and around 30% of that (1.6 hectares) is registered in the PROCAMPO program.

Farm assets tend to be slightly smaller than herd values, but investments on the farm tend to be more than investments in livestock. All of these numbers are fairly close, so these two categories of capital and investment are appropriate for making comparisons.

Earlier we discussed the potential importance of local characteristics in determining how migration and remittances can effect productive investment. There are several variables in our data that measure important characteristics at a local level. These include the local wage, local soil quality, local land holding rights, and levels of irrigation in local agriculture, and local migration rates. Data on recent experience with natural disturbances that lead to agricultural trouble such as drought or flood in the village are used to help identify the investment portion of the model. Including the local wage allows us to examine how labor market conditions in the sending area can impact activity choice, income and investment. Soil quality and irrigation are part of what differentiates production technologies from place to place. Land holding rights may have an impact on security of investment, and land rights and irrigation may relate to existing levels of capital as well. Including these variables in our empirical specification allows us to examine the relationships between local productivity, local labor markets, and local migration networks and investment.

Migration capital is represented in the data at both the household and the village level. Village level migration rates represent local networks that may allow a potential migrant to have easier access to a far away labor market. Household experience in migration and whether a household member speaks English are measures of migration capital at the household level. Since we can measure both household and local migration networks, we can also compare the impacts of these two types of networks. However, making concrete judgments on that comparison will be difficult due to the fact that there could be many other factors at work in determining the true level and value of migration capital. Education may also ease access to foreign or distant labor markets, but is not specific to migration enough that it can be thought to represent migration capital.

To implement our empirical model, we need to identify a destination or potential destination in the U.S. and another in Mexico for migrants that have left or could leave each household. For all households with migrants out in either type of migration (internal or international) the most common destination state for the household is used. For example, if a household has three migrants in the U.S., two are in California and the third is in Ohio, we will use California as the most likely destination for that household. For households that do not currently have migrants out in Mexico or the U.S., we first turn to past migration decisions. If a household has never had migrants out, we use the most common destination at the village level. For villages that have not experienced migration, we use the most common destination for migrants from the Mexican state where the village is located.

There is variation in our data set in the migrant destinations in the United States, as migrants from different parts of Mexico have connections to different states in the U.S. We use this variation to help to measure the relationship between economic characteristics of the migrant destination and labor and investment decisions in the sending region.

In the empirical model we use changes in GDP and unemployment in these states as exogenous variation to help identify the model. Because some of these variables are based on decisions, using them as something that represents exogenous variation can be tricky. Since we are not using a long term characteristic of any of the destinations, but just a measure of the changes that happened there over the space of a few years, we believe that concerns of endogeneity are unfounded. In order for the changes to be correlated with decisions, it would have to be true that migrants and potential migrants were able to predict the growth that preceded

the financial crisis and the impacts of the crisis as they varied across different states in the U.S. and in Mexico. We do not believe this to have been the case.

5. Empirical Results

5.1 Income generating activity participation

Table 2 presents the results from estimating the activity choice equation (44) for each income generating activity. We discuss the results for each activity in turn.

5.1.1. Agricultural home production

Opportunities in the U.S. destination are negatively connected to the likelihood of participating in agricultural home production. The positive, significant coefficient on unemployment rates in the U.S. means that better opportunities, or less unemployment, at the potential migrant destination lead to a decrease in the likelihood that households engage in local agricultural production. The relationship between GDP growth in the potential U.S. destination and participation in agricultural home production is more direct: more growth in the destination area leads to less likelihood of participation in agricultural activities. Privately held farm-related assets are positively related to the likelihood of participation in agricultural activities.

Irrigation and good soil in the village are negatively related to participation, possibly because in those areas with more irrigation and better soil, returns to scale are greater, and so fewer households have held out in small-holder production. This might suggest that there is more specialization in economic activities in those areas.

Primary education has a positive impact on the decision to engage in farm activities, although the insignificant result on secondary education suggests that more advanced education is not as closely linked to farming. Compared to the other years in the data, 2010 saw less likelihood of households being self-employed in agriculture, reflecting a global trend in the movement of labor into off farm activities.

5.1.2. Wage work

Education and local wage rates positively impact the likelihood that a household will engage in wage work. Experience working in the U.S. decreases the likelihood of working in the

wage labor market in rural Mexico. Higher unemployment in potential U.S. destinations leads to a decreased likelihood of wage labor activity.

Living in a village with secure land rights has a positive impact on the likelihood of wage work participation. This may be due decisions of other households to invest in local production and the resulting need for paid laborers; or due to livelier economic conditions in general, and greater demand for non-farm goods and services. Alternatively, secure rights may make the household more comfortable diversifying, if less secure rights are only renewed by continued activity on the farm.

There are several other variables that play strong theoretical roles in household activity decisions, and that appear to have a statistically significant effect on activity choice. The first is experience in wage work, which has a positive relationship with wage work in general, at the 10% level of significance. Since the model uses median village wage rates, the coefficient on experience is both a direct effect and an indirect effect through the wage rate received by an individual. Also in this category are GDP growth in potential migrant destinations in both the U.S. and Mexico. These last two factors tend to have an inverse relationship with the likelihood of engaging in wage work, significant at around the 10% level.

Another result of note is that in both 2007 and 2002 households were less likely to engage in wage work activity than in 2010, on average. The difference between 2010 and 2002 is not statistically significant, but the difference between 2007 and 2010 is significant.

5.1.3. Migration within Mexico

Education, experience and landholdings registered in the government agricultural support program PROCAMPO are all positively connected to within Mexico migration. Experience working in the United States and GDP growth in potential U.S. destinations are both negatively related to the probability that a household participates in internal migration. Education represents better opportunities in potential internal destinations. PROCAMPO land, which is eligible for a government support payment as long as it is in some productive use, may represent secure funding for a move. Both of those should drive households towards internal migration. Past experiences working in the U.S., and expectations of better returns in the U.S. should put negative pressure on internal migration.

Secure land rights within the village are related to lower likelihood of internal migration. While secure rights, like PROCAMPO land, may represent a source of funding for migration, secure land rights may represent a specialization in agriculture that increases local opportunities in a way that PROCAMPO cannot.

GDP growth in potential destinations within Mexico has a negative coefficient at the 10% level. The result on GDP growth in Mexico was unexpected. One possible explanation for the negative coefficient is that this variable is not measured on a fine enough scale. Many households migrate to destinations within the state of origin, so the growth of the home region may be correlated with growth of the potential destination. Another possible factor could be that, since we are only observing the rural population, the highest growth areas may attract workers from other urban areas, crowding out rural migrants.

In general these results are not surprising. Education is positively connected with economic activity in general, so having positive coefficients on all four equations suggest that more education means households are less likely to be inactive. However, secondary education seems to more important in determining migration participation than anything else. Experience in migration is self-perpetuating. With the exception of the impact of Mexican state GDP growth on migration within Mexico, the external economic indicators fall within reasonable expectations.

5.1.4. Migration to U.S.

High unemployment in U.S. destinations appears to be a major deterrent to migration. GDP growth in the U.S. state of migration does not produce a measurable effect on the likelihood of migrating. Opportunities within Mexico, measured by GDP growth in Mexican destinations, decrease the likelihood of U.S. migration. While education has positive impacts in all four activity equations, the largest impacts are on U.S. migration. Living in a village with lots of irrigated land also puts upward pressure on the likelihood of migration to the U.S., as does experience with migration to the U.S. The impact of irrigated land on probability of migration could mean that villages with lots of irrigated land have the ability to finance migration. Since irrigated land decreases the likelihood of self-employment in agriculture, this could mean that villages with irrigation tend to have more diversified economies, and more households that are

able to finance migration. Farm assets held by the household are negatively correlated with U.S. migration.

The relationship between probability of migration, unemployment, and GDP growth suggests that likelihood of finding a job is the most important determinant for migration. If GDP growth correlates with wages in the destination, changes in wages are not enough to deter migration. It may be true that measures of GDP growth in U.S. states do not correlate strongly with potential earnings for migrants.

Migration to either the U.S. or to other parts of Mexico is determined by a mix of factors related to household specific characteristics, household settings, and activity specific variables. Looking at the drivers of different types of migration, the mix of local and household factors is close to even. They each depend on some kind of household assets (PROCAMPO land for internal migration, productive assets for international) as well as education. Each type of migration is self-perpetuating, with experience in that type of migration driving continued participation. Both internal and international migration are negatively related to local wages, although only internal migration has a statistically significant relationship with local wages. Local conditions may be more important in determining internal migration than they are in determining international migration.

5.2 Selectivity-corrected income generation

Table 3 presents the selectivity-corrected results for income generation from estimation equation (45) for each income generating activity. We discuss income from each activity in turn.

5.2.1. Income from agricultural home production

Privately held assets and good soil are a boon to households that participate in agricultural activities. One interesting result in this category is that education does not have a significant effect on income from agricultural home production.

5.2.2. Income from wage work

Education and wages are big drivers of wage income, and it appears that wage workers were able to make more money in 2010 than in 2007 or 2002. Experience does not appear to be important, although it is important to remember that this model encompasses all forms of wage

work. This result should not be interpreted as saying that there are not forms of wage work that value experience, but that on average, wage earnings in rural Mexico do not reward experience. Unlike experience, education does correlate with higher wages. Finishing secondary school leads to a much larger increase in household income than does finishing primary school.

5.2.3. Income from remittances from within Mexico

GDP growth in the destination is positively correlated with increased remittances on average, but not at a statistically important level. The same can be said for experience in working in internal migrant destinations. Household that speak an indigenous language tend to get more money remitted back from migrants working in other parts of Mexico, but only at a 14% significance level. The only variable that is statistically significant in determining remittances from internal migrants is the year, with 2007 seeing an increased likelihood compared to the other years in the surveys.

5.2.4. Income from remittances from the U.S.

The proportion of households in the village that participate in migration to the U.S. This variable has a significant positive effect on remittances from the U.S., suggesting that village level effects are important in determining remittances. The result could mean that villages with high migration rates become dependent on remittances, although reaching that conclusion would be premature. Another important possibility is that instead of substituting for other income, remittances bolster consumption beyond what the household income itself can afford. This may seem like dependence on remittances, but in this scenario it does not mean an end to meaningful economic activity in the village.

In Table 2, unemployment rates had an impact in probability of migration, but GDP growth did not. Here, in Table 3, we find the opposite effects on the income from remittances. GDP growth in the U.S. state leads to more remittances, but the unemployment rate has an impact that is not measurably different than zero. GDP growth has a positive effect on income at the 10% level of significance. The size of the coefficient, coupled with the strong theoretical foundation for the effect and with the wide variability in the ways that migrants experience economic growth leads us to the conclusion that is an economically important result.

Experience working in the U.S. has a positive effect on remittances from the U.S. that is significant at a 10% level. This fits with the ideas discussed earlier about migration capital. Experience in international migration is about more than just work experience, and actually builds value in a much different way than work experience does. While it has a positive relationship on average with remittances, education does not seem to have a statistically significant effect on remittances. Education may drive the decision to migrate, but it does not appear to yield returns to the households that migrants come from in the form of increased remittances.

5.3 Investment

Results for the probability of investment regressions are in Table 4. Results for the selectivity-corrected investment level regressions are in Table 5.

5.3.1. Probability of farm investment

Households with higher wage incomes and higher remittances from other parts of Mexico in the previous period are less likely to make investments in crop related activities. This may be a sign of the agricultural transformation; households with non-agricultural opportunities and connections are not interested in a more robust participation in agriculture. A similar, though not statistically significant, coefficient on U.S. remittances may support this conclusion. One interesting take-away here is that no labor income source has a significant, positive impact on the probability of investment.

Income from PROCAMPO transfers has a significant, large, and positive impact on the likelihood that the household invest in crop related activities. If the household is subject to a cash constraint that limits capital accumulation it would be reasonable to think that effect of government agricultural support payments might be similar to the effect of other farm income. Since farm income has no discernible effect on likelihood of investment, this hypothesis seems unlikely to be true. PROCAMPO payments are meant to be decoupled from on farm decisions, but this result suggests that the program is not as separate from farm decisions as it was intended to be.

Previous literature has studied the impacts of farm payments on production decisions in numerous aspects. Particular attention has been paid to how farmers respond to restrictions (such

as land use restrictions) in the payment program (see e.g., Just and Kropp, 2013); how expectations or beliefs about future changes to the program can shape farmers reactions (Hendricks and Sumner, 2014; Bhaksar and Beghin, 2010); and even the difficulty of measuring response to a program when rules are not standardized across all participants (McDonald and Sumner, 2003). Each of these may have some role in the way that farmers react to PROCAMPO payments.

The restrictions that farmers face in Just and Kropp's (2013) study are based on land use. Farmers in the sample that receive program payments are prohibited from planting certain non-program crops. In this study, the authors show that the restrictions cause farmers to behave as if the payments were not decoupled. In our theory model, we suggested that the use restriction on PROCAMPO land (must be in productive use) could result in an effective labor constraint on the PROCAMPO land. If the extensive margin of land acreage to program crops in Just and Kropp's (2013) findings could be extended to this labor constraint, that might mean that PROCAMPO households have a different optimal input mix than other households, and may invest more because of that. This also links to the key theoretical idea from our theory model that labor use decisions are an important determinant of investment. If the program payment is changing labor use decisions, then we should expect it to change investment.

Another possible explanation for the high level of investment impacts of PROCAMPO payments is that households may believe that the program will be re-evaluated at some point in the near future. Hendricks and Sumner (2014) and Bhaksar and Beghin (2010) both use numerical simulations to show that if farmers think that their eligibility for the program may be updated in the future, they may make planting decisions to influence that updating. It seems unlikely that farmers would think that having more capital invested in will help their eligibility. A more likely explanation could be that the program crops (or what farmers believe will be the program crops) are more responsive to productive capital than other planting options, so that farmers with a stake in the PROCAMPO program are more likely to invest because of their crop choices.

McDonald and Sumner (2003) highlight the difficulty of measuring program impacts when not all participants are under the same set of rules. Their example is the rice support program in the U.S., and they show that aggregating across too many program types can lead to measurements that confound multiple effects occurring across different subsets of the program.

PROCAMPO is nominally a national program, but it is administered by local offices. In an analysis of welfare impacts, Taylor and Filipski (2014) demonstrate that reported payments are not standard and in fact vary by regional office. If the different offices effectively enforce different rules, then our analysis might not be measuring the investment impacts of PROCAMPO properly. In particular, there may be some selection into different levels of payments that correlates with investment incentives.

Education plays a role in investment decisions according to our model, with more education leading to a greater probability of investment. This is the first point in our analysis in which we have found evidence that secondary education has a measurable effect on agricultural activities. Secondary education, though not linked to higher incomes in agriculture or more participation in agriculture, is here linked to a greater likelihood of investment in crop activities.

There are a few more details on the relationship between the investment decision and household characteristics. Households that speak an indigenous language are less likely to make investments in farm related capital, and larger households are also less likely on average, although the effect related to household size is less statistically strong. Indigenous households may have more trouble accessing markets for capital goods, or may be more tied to traditional farming methods.

Households who live in villages with lots of irrigated land are less likely to invest, and so are those whose villages have recently been hit by a commonly felt agricultural shock. Villages with higher levels of irrigation may employ different production technologies that make capital investment less attractive. Villages that have recently experienced agricultural shocks may have limited ability to increase capital stock if incomes or assets have been drawn down by the shock. Wages and local migration rates have no statistical effect that we can find.

5.3.2. Probability of livestock investment

Most sources of earned income do not have a big statistical impact on the probability that a household will invest in livestock. The exception is that higher levels of remittances from migrants located in other parts of Mexico are connected to lower probabilities of livestock investments. Transfer payments for PROCAMPO and PROGRESA also have significant relationships, but in those cases the relationships are in the positive direction. Both sources of government transfers lead to greater probability of investment in the livestock herd. In rural areas

where households lack access to formal credit, this could be the equivalent of savings. It could also represent government programs allowing households to increase their intake of animal products, and the related fats and proteins that those animal products represent.

Local or village level variables are also importantly related to the probability of livestock investments. While the receipt of remittances from household members working in other parts of Mexico has a negative effect, living in a village with lots of households who have members working in other parts of Mexico has a positive effect on the probability of investing in livestock. This may mean that remittances that flow in from other parts of Mexico allow a household to decrease its own livestock activities and substitute with products from other households within the village, who are apparently likely to increase their herd size. Households located within villages that have experienced agricultural difficulties are more likely to make livestock investments. This could be related to a savings or insurance effect.

Households that speak an indigenous language are also more likely to make livestock investments. Education is not importantly related to livestock investment. The coefficients are very small and the effects are not significant.

5.3.3. Level of farm investment

Higher levels of crop income lead to larger future investments in crop production. This may mean that the amount of capital being used in crop farming in rural Mexico is growing. Such a change would be a standard characteristic of agricultural transformation, common as societies move into more industrialized forms of production. No other sources of earned income play an important role in determining the amount of investment made in crop activities. PROCAMPO payments are very importantly linked to investment, with each additional peso of PROCAMPO income having about three times as big of an impact on investment levels as a peso of crop income in the last period. Linking back to the possible reasons that PROCAMPO would increase the likelihood of investing, there may be a constraint that locks labor into the PROCAMPO land. The households that control that land may have a higher optimal level of capital than other farm households, due to the difference in labor allocation. From an econometric standpoint, PROCAMPO payments may be serving as a proxy for a different production technology or paradigm.

Education plays a role in determining the level of investment similar to the role it plays in determining whether or not the investment happens. More adults with secondary education make a bigger impact on investment levels, both in terms of statistical significance and the magnitude of the coefficient.

Large households, indigenous households, and those within villages that have high within Mexico migration rates are likely to make smaller investments. So are those who have an English speaker. Most of these variables are likely linked to forces that are pulling workers away from the rural areas, and possibly providing their families with other income and opportunities besides crop farming.

Households in villages with good soil are likely to make smaller investments. This could be linked to concentration, meaning that on average fewer households are significantly involved in farming and so they will make smaller investments. It could also be linked to higher levels of capital in the previous periods, and so smaller investment would be needed to reach the optimum.

5.3.4. Level of livestock investment

Agricultural income, land holdings and irrigation in the village are the main positive drivers of levels of livestock investment. Remittances from the United States and good soil in the village are statistically significant determinants in a negative direction. All three positive factors can be directly related to livestock production, and suggest that households who are heavily involved in agricultural activities can perpetuate that involvement with investment in livestock. The negative factors most likely represent tradeoffs, or other investments that may be more advantageous that livestock.

Remittances from the United States convey income and information. If that information means that better opportunities can be accessed then investment in livestock may be less worthwhile. Better opportunities could mean that working with livestock is less profitable than going to work in the U.S. Or, probably more realistically, it could mean that income sharing agreements with migrants in the U.S. provide a better form of savings and insurance than keeping livestock can.

Good soil in the village has a negative relationship with both types of investment that are measured in this model. This is not exactly as expected, although it does show that local

characteristics are important determinants of investment. This relationship may mean that other investments, aside from the ones measured here.

Looking back at some of the earlier results, in villages with good soil, households are less likely to participate in agricultural activities, but if they do the income they earn is much higher. This suggests that in these villages, agricultural activities are more likely to be concentrated into a small number of wealthy producers. If this is the case, this would mean that most households in the town are not going to make to make big investments in agricultural activities. The big, wealthy farmers in those towns may be better capitalized, and so may also be less inclined to make significant investments at this point.

6. Discussion and Conclusion

In this paper, we investigate the circumstances and situations in which migration and remittances have either negative or positive effects on economic development in migrant sending areas. Specifically, we develop a model of activity participation, income, and investment decisions made by households. We use this model to measure the impact of migration and remittances on investments by households in rural agricultural production in Mexico using data from the National Survey of Rural Households in Mexico.

6.1. Migration and investment

According to our theory model, investment decisions are affected by consumption, labor allocations, and the production function. One way to evaluate that model is to look at the empirical results and see if the significant factors in determining investment can be related to consumption, labor allocations or productivity. Key drivers of farm investment were PROCAMPO payments, education, and income from crop production in the positive direction. Household size, indigenous language speaking, internal migration rates and villages with good soil were key variables that had effects in the negative direction.

Crop income and good soil definitely relate to the production function. The effect on indigenous households may also be production related, if indigenous households are likely to be using a different technology than other households. Household size and internal migration rates are likely linked to labor allocations. PROCAMPO payments may relate to consumption, labor allocation, or the production function (if households that receive PROCAMPO payments are

more likely to be specialized in agriculture, they may use different production technologies than other households). Education could relate to all or any of the paths, although the lack of effect of education on crop income suggests that the production function is not the primary path. Each of the factors that we have found to be statistically significant seems to relate to one of the three paths of impact laid out by our theoretical model.

According to the empirical results, migrant remittances do not increase investment. Remittances from the U.S. are of borderline significance decreasing the levels of livestock investment. Remittances from migrants working in other parts of Mexico make investment in either category less likely, and decrease the size of investments made in crop activities. There are indirect relationships between migration and investment that are measured in the model. Households with higher education are both more likely to migrate and more likely to invest.

Understanding the relationship between education and migration is an important step towards understanding how migration might indirectly impact productive investment. If migration and or migrant remittances in the past helped to increase the number of educated adults in households, this would have an indirect effect on investment through education. Education appears to increase the probability of participation in both categories of migration more than it increases the probability of participation in other activities, especially at the secondary level. Education also increases both the probability of and levels of productive investment in crop activities.

Remittances and migration impacting investment and productivity through education could be consistent with the mixed findings of studies in the past. Access to education varies greatly across rural areas. If the primary impact of migration and remittances on productive investment filters through education, then the cost of making the investment in the end varies with the cost of education, and so with the ease with which rural households can access education. In that scenario, areas where education was easier to access would seem to have significant impacts on investment from migration and remittances, where other areas would not.

One factor that complicates the analysis of migration-investment-education relationships is that education has been changing dramatically, both in terms of the cost to access it and the value that it has in rural Mexico. The PROGRESA program was developed by the Mexican government to decrease the costs of acquiring education. As industrial production (the automobile industry, for example) becomes more prevalent in Mexico, the returns to education

are likely to increase. Both of these factors change the decision making process for rural Mexicans considering education.

6.2. Modeling remittances

One question that should come up from the results is whether or not the empirical model has been able to account for migration and to predict remittances in a meaningful way. The significance and correlation measured by the equations that predict remittances are fairly low, and it does not appear that selection into migration is an important factor in determining remittance behavior.

Migration and remittances are often modeled as two connected processes, although there are ways that they may be independent. Many migrants are not actually remitters. In the modeling above, we have followed the majority of the literature in assuming that the decision to remit is made after the decision to migrate, and so that migrants can be separated into two categories: those that remit and those that do not. It could be possible that some of this decision is made concurrent with migration; that some migrants effectively leave the household that they come from. It would then be correct to divide migrants into three categories: those who remit, those who do not currently remit but may at some point, and those who will never remit. Unfortunately, the dataset does not contain a variable that could reasonable be used to identify the three groups in more detail than we have already done.

Another possibility that could lead to the results that we have presented above is that there are multiple processes that are used by different households to select into migration and remittances. This would mean that the lack of effect that is measured by the model is the result of from many different effects that are in different directions, and that those differences are not related to the variables that have been modeled.

There are many possibilities that would discount our results modeling remittances, but the overall model that we have estimated is consistent with the results that we do get on remittance determination. Experience working in the U.S. and the portion of households members working in the U.S. both increase remittances from that location. These findings are consistent with the other findings in later stages that remittances do not lead to investment. The determinants of remittance suggest that households see remittances as a long term income source, not a short term one intended to overcome a constraint that is preventing investment.

Additionally, the growth of GDP in the destination state has a significant role at the ten percent level. For these reasons, we believe that the model has adequately predicted remittances from the U.S.

Remittances from Mexico are modeled with about the same statistical precision as those from the U.S. The GDP growth variable does not have a significant effect in this regression, however. This is not entirely consistent with expectations, but can be explained in a satisfactory manner. GDP growth in an internal destination is likely to be more correlated with economic growth in the region of migrant origin. The fact that predicted remittances from Mexico have a statistically significant role in investment decisions eases concerns that the predictions are all noise. This significant effect is a reason to believe that remittances from Mexico are also modeled with sufficient precision.

6.3. The role of PROCAMPO in agricultural investment

A key feature of the PROCAMPO program is that it is meant to be decoupled from production decisions. To accomplish this, the payments are based on crop plantings that were surveyed in 1993. This way, current period decisions do not impact current period payments. However, the results of this study suggest that, while the amount of payments may not be impacted by on farm decisions, on-farm decisions may be impacted by the receipt of and the amount of payments.

One possible explanation is that the receipt of transfer payments has allowed for the release of a cash income constraint. If this were the main route of interaction, we would expect that receipt of other kinds of cash transfers would have a similar impact. Looking at the tables, it is clear that this is not true. PROGRESA transfers do not have a similar effect on crop investments. Neither do most income sources. It is also interesting to note that neither government transfer has a significant effect on the level of investment in the livestock herd. The large, significant effect of PROCAMPO transfers is unique to crop investment, and differs from the effects of other types of income, and cannot be considered the result of releasing a cash constraint.

Because receipt of PROCAMPO payments is conditioned on participation in agricultural activities, it is possible that those households who receive the payments are in some way inclined towards participation in those activities. However, the large number of households that do

receive the payments suggests that this may not be the case. Another possibility is that households have some belief that continued participation and investment in agriculture will allow them to keep receiving the payments.

If households who receive PROCAMPO payments stay involved in agriculture because of the payments, then the status of PROCAMPO as a decoupled payment program would be eroded. While it still may not be impacting the decision of what to plant, it may impact the decision to plant instead of spending time on other activities. The impact of PROCAMPO payments on agricultural investments suggests that these payments are keeping households in agricultural production, making investments that would not otherwise be made.

PROCAMPO payments and farm income lead to increased investments in crop production. Households that are already involved in agriculture are still investing, meaning that the amount of capital in Mexican agriculture may be increasing. This could be aiding the agricultural transformation, if it happening to increase the capital to labor ratio and is accompanied by labor moving away from the farm.

PROCAMPO's effects are important for the future of rural Mexico. PROCAMPO payments could be aiding the capitalization of Mexican agriculture, or they could be forestalling the move away from agricultural activities. Answering this question is beyond the scope of the current study, but is something that could be important for Mexico as well as for many other countries that have similar programs. The difference in the two possibilities comes down to labor allocations, and whether PROCAMPO is trapping labor on the farm or allowing it to leave.

6.4. Local and regional characteristics as determinants of migration and investment decisions

One of the hypotheses put forward in the introduction is that local and regional characteristics can play an important role in both migration decisions and investment decisions. The empirical results have borne that idea out. Village level variables describing irrigation, land rights, and soil have been shown to have important relationships to migration decisions, as well as decisions on whether to invest and how much to invest. Local migration rates and wages also play a role, as do local agricultural shocks. The role of local level variables as determinants of both migration and investment could explain some conflicting findings from past studies.

6.5 Conclusions

According to our empirical results, migrant remittances did not increase rural investment in agricultural production. Remittances from migrants working in other parts of Mexico were a deterrent to agricultural investment. Regional or village level variables that relate to parameters of agricultural production functions are important in determining activity and investment decisions. Our theoretical model suggests that activity participation decisions, production parameters, and consumption choices are the key factors that will determine investment, and the empirical results support that view. These are new and important findings that should be folded into future research efforts. Our contribution towards future research will hopefully inform the perspective of what needs to be examined to understand migration and development relationships.

Indirect effects of migration and remittances on investment may occur through education. Alternatively, the effects that education has on both migration and investment may have been perceived as a more direct relationship between the two. It is also possible that some other factor that drives education also has a relationship to both migration and investment. These indirect relationships suggest that accounting for selection into migration and into investment are important steps to measuring the impacts of migration and remittances on investment. Exploring these indirect relationships in future research may help to advance our knowledge of both migration and investment in rural areas of the developing world.

The role of government transfer payments in rural Mexico may be different than what was intended. Our results show that the use of PROCAMPO payments may be very targeted, and have different implications for households than other sources of income. While this was not the primary focus of our research, it is an important finding that may lead to interesting new directions for future research.

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Table 1. Summary Statistics

	Observations	Mean	Standard error	
agricultural troubles at household level (dummy)	2535	0.37	0.48	
agricultural troubles in village (dummy)	2535	0.37	0.27	
English speaker in household (dummy)	2520	0.01	0.10	
experience in wage work (years, maximum in household)	2535	7.11	8.48	
experience migrating within Mexico (years, maximum in household)	2535	6.58	76.85	
experience working in U.S. (years, maximum in household)	2535	1.42	2.79	
farm assets (100,000 pesos)	2535	0.065	0.31	
farm investments (100,000 pesos)	1690	0.025	0.30	
GDP growth in potential Mexican destination state	2535	0.04	0.03	
GDP growth in potential U.S. destination state	2535	0.01	0.01	
grandparent migrated within Mexico (dummy)	2520	0.09	0.29	
grandparent migrated to U.S. (dummy)	2520	0.05	0.22	
herd value (100,000 pesos)	2535	0.080	0.23	
household land holdings (hectares)	2535	5.56	34.88	
household land holdings enrolled in PROCAMPO (hectares)	2535	1.64	4.89	
household size	2535	7.03	3.54	
income from agricultural home production (pesos)	1012	16,374.72	52,754.97	*
income from remittances from within Mexico (pesos)	778	7238.75	26,835.18	*
income from remittances from U.S. (pesos)	552	22,688.99	76,143.25	*
income from wage work (pesos)	1685	42,188.66	56,649.11	*
indigenous language spoken in household (dummy)	2520	0.28	0.45	
livestock investment (100,000 pesos)	1690	0.020	0.22	
median wage in village (pesos)	2271	115.09	48.74	
number of adults in household with primary education	2535	1.81	1.86	
number of adults in household with secondary education	2535	2.19	2.11	
participation in home agricultural production (dummy)	2535	0.40	0.49	
participation in wage work (dummy)	2535	0.66	0.47	
participation in migration within Mexico (dummy)	2535	0.31	0.46	
participation in migration to U.S. (dummy)	2535	0.22	0.41	
PROCAMPO transfer income (100,000 pesos)	2535	0.01	0.03	
PROGRESA transfer income (100,000 pesos)	2535	0.02	0.04	
share of local households with a member working in another part of Mexico	2535	0.30	0.17	
share of local households with a member working in U.S.	2535	0.21	0.19	
share of village land held with secure property rights	2535	0.90	0.23	
share of village land that is irrigated	2535	0.28	0.34	
share of village land with good soil	2535	0.42	0.29	
unemployment rate in potential U.S. destination state	2535	7.36	2.88	

* - these variables are measured in 100,000 pesos in the investment stages of the empirical model

Table 2: Probit Results for Income Generating Activity Participation

	Dependent variable is probability of participation in:											
	Ag home production			*Wage work*			*Migration within Mexico*			*Migration to U.S.*		
	Coefficient	Std. Err.		Coefficient	Std. Err.		Coefficient	Std. Err.		Coefficient	Std. Err.	
number of adults in household with primary education	0.07	0.02	***	0.04	0.02	**	0.05	0.02	**	0.11	0.02	***
number of adults in household with secondary education	0.01	0.01		0.03	0.01	*	0.10	0.02	***	0.13	0.02	***
share of village land with good soil	-0.40	0.11	***	0.05	0.10		-0.13	0.12		-0.12	0.15	
share of village land held with secure property rights	0.11	0.15		0.37	0.14	**	-0.69	0.15	***	0.35	0.26	
share of village land that is irrigated	-0.20	0.09	*	0.09	0.09		-0.04	0.10		0.28	0.12	*
household land holdings (hectares)	0.002	0.001	*	-0.001	0.001	***	0.001	0.001		0.000	0.001	
household land holdings enrolled in PROCAMPO (hectares)	0.05	0.01	***	-0.02	0.01		0.03	0.01	***	0.01	0.01	
farm assets (100,000 pesos)	0.22	0.10	*	-0.17	0.09	†	-0.09	0.11		-0.38	0.13	**
herd value (100,000 pesos)	1.31	0.15	***	-0.45	0.12	***	0.14	0.14		0.03	0.15	
median wage in the village	-0.006	0.001	***	0.004	0.001	***	-0.002	0.001	**	-0.001	0.001	
experience in wage work (years)	0.00	0.00		0.02	0.01	†	-0.01	0.01		0.00	0.01	
GDP growth in potential Mexican migrant destination state	1.12	1.25		-1.99	1.22		-2.67	1.40	†	-4.28	1.75	*
experience migrating within Mexico (years)	0.00	0.00		0.00	0.00		0.26	0.01	***	0.00	0.00	
GDP growth in potential U.S. destination state	-4.34	2.15	*	-0.14	2.00		-11.26	2.54	***	-1.08	2.77	
unemployment rate in potential U.S. destination state	0.07	0.03	**	-0.08	0.03	*	0.00	0.03		-0.15	0.03	***
experience migrating to U.S. (years)	0.01	0.01		-0.05	0.01	***	-0.02	0.01	†	0.33	0.02	***
year=2002	0.40	0.16	**	0.00	0.14		-0.09	0.18		-0.18	0.20	
year=2007	0.27	0.17		-0.43	0.17	**	-0.19	0.20		-0.45	0.22	*
# observations	870			1530			707			488		

Significance codes: † 10% level, * 5% level, ** 1% level, and *** 0.1% level. Experience variables measure the maximum years in household.

Table 3: Selectivity-Corrected Results for Income Generation

Dependent variable is:			
Income from agricultural home production (pesos) (n=870)	Coefficient	Standard Error	
number of adults in the household with primary education	-726.83	1008.77	
number of adults in the household with secondary education	-225.98	855.19	
share of village soil considered good	23,860.66	8440.16	***
share of village land held with secure property rights	15,319.96	10,174.11	
share of village land that is irrigated	-9845.08	7085.92	
household land holdings (hectares)	-10.28	34.91	
household land holdings enrolled in PROCAMPO (hectares)	123.05	307.53	
farm assets (100,000 pesos)	26,738.92	4368.05	***
herd value (100,000 pesos)	9271.06	6234.27	
year = 2002	-13,263.32	4880.27	***
year = 2007	-17,774.15	4358.85	***
inverse Mills ratio	2136.76	17,536.52	
Income from wage work (pesos) (n=1530)	Coefficient	Standard Error	
number of adults in the household with primary education	2285.99	712.85	***
number of adults in the household with secondary education	7035.49	673.51	***
median wage in the village (pesos)	169.34	30.32	***
experience in wage work (years, maximum in household)	65.71	133.85	
year = 2002	-9678.04	3821.69	**
year = 2007	-13,454.69	3354.35	***
inverse Mills ratio	-177,028.90	22,152.96	***
Income from remittances from within Mexico (pesos) (n=707)			
GDP growth in potential Mexican migrant destination state	49,587.83	44,103.53	
experience migrating within Mexico (years, maximum in household)	4.21	7.52	
household size	392.17	323.27	
indigenous language spoken in household (dummy)	3292.03	2215.58	
year = 2002	2399.97	3531.29	
year = 2007	4906.68	2453.74	*
inverse Mills ratio	-10,069.33	8080.74	
Income from remittances from the U.S. (pesos) (n=488)			
GDP growth in potential U.S. destination state	438,052.50	253,659.20	†
unemployment rate in potential U.S. destination state	-848.02	2897.01	
experience migrating to U.S. (years, maximum in household)	4043.51	2216.64	†
share of local households with a member working in U.S.	45,961.36	22,137.42	*
year = 2002	-2045.94	16,323.17	
year = 2007	-2581.82	17,134.82	
inverse Mills ratio	69,056.99	51,713.66	

Significance codes: † 10% level, * 5% level, ** 1% level, and *** 0.1% level

Table 4a. Probit Results for Farm Investment Participation

Dependent variable is probability of farm investment	Coefficient	Standard Error	
lagged predicted agricultural home production income (pesos)	0.15	0.45	
lagged predicted wage income (pesos)	-1.02	0.47	*
lagged predicted Mexico remittances (pesos)	-4.78	1.78	**
lagged predicted U.S. remittances (pesos)	-0.97	0.72	
household land holdings (hectares)	0.00	0.00	
Progresa transfers (100,000 pesos)	1.68	1.21	
PROCAMPO transfers (100,000 pesos)	3.85	1.44	**
agricultural troubles in village (dummy)	-1.08	0.39	**
local within Mexico migration rate	0.04	0.36	
local U.S. migration rate	0.40	0.42	
median wage in village (pesos)	0.00	0.00	
share of village land that is irrigated	-0.36	0.17	*
share of village land held with secure property rights	-0.15	0.29	
share of village land with good soil	0.20	0.19	
number of adults in household with secondary education	0.17	0.04	***
number adults in household with primary education	0.11	0.03	***
agricultural troubles at household level (dummy)	0.17	0.11	
household size	-0.03	0.02	†
indigenous language spoken in household (dummy)	-0.29	0.14	*
English speaker in household (dummy)	-0.08	0.47	
grandparent migrated within Mexico (dummy)	-0.05	0.15	
grandparent migrated to U.S. (dummy)	0.27	0.18	
# observations	1399		

Significance codes: † 10% level,* 5% level, ** 1% level, and *** 0.1% level

Table 4b. Probit Results for Livestock Investment Participation

Dependent variable is probability of livestock investment	Coefficient	Standard Error	
lagged predicted income from agricultural home production (pesos)	0.53	0.39	
lagged predicted income from wage work (pesos)	0.20	0.38	
lagged predicted income from remittances from within Mexico (pesos)	-4.80	1.41	*
lagged predicted income from remittances from U.S. (pesos)	0.52	0.59	
household land holdings (hectares)	0.00	0.00	
Progresa transfers (100,000 pesos)	2.37	1.02	
PROCAMPO transfers (100,000 pesos)	2.44	1.37	†
agricultural troubles in village (dummy)	0.78	0.32	**
local within Mexico migration rate	0.96	0.29	***
local U.S. migration rate	-0.10	0.33	
median wage in village (pesos)	0.00	0.00	
share of village land that is irrigated	0.12	0.15	
share of village land held with secure property rights	-0.04	0.24	
share of village land with good soil	-0.15	0.17	
number of adults in household with secondary education	0.01	0.03	
number of adults in household with primary education	0.00	0.03	
agricultural troubles at household level (dummy)	0.30	0.09	***
household size	0.01	0.01	
indigenous language spoken in household (dummy)	0.22	0.11	*
English speaker in household (dummy)	0.04	0.40	
grandparent migrated within Mexico (dummy)	-0.25	0.13	†
grandparent migrated to U.S. (dummy)	0.00	0.18	
# observations	1399		

Significance codes: † 10% level, * 5% level, ** 1% level, and *** 0.1% level

Table 5a. Selectivity-Corrected Results for Level of Farm Investment

Dependent variable is level of farm investment (100,000 pesos)			
	Coefficient	Standard Error	
lagged predicted agricultural home production income (pesos)	2.04	0.44	***
lagged predicted wage income (pesos)	-0.29	0.27	
lagged predicted Mexico remittances (pesos)	-0.55	2.41	
lagged predicted U.S. remittances (pesos)	-0.30	0.71	
household land holdings (hectares)	0.01	0.00	*
Progresa transfers (100,000 pesos)	0.13	1.16	
PROCAMPO transfers (100,000 pesos)	6.10	1.83	***
local within Mexico migration rate	-0.79	0.34	*
local U.S. migration rate	-0.34	0.45	
median wage in village (pesos)	0.00	0.00	
share of village land that is irrigated	0.15	0.15	
share of village land held with secure property rights	-0.41	0.27	
share of village land with good soil	-0.38	0.18	*
number of adults in household with secondary education	0.13	0.05	**
number of adults in household with primary education	0.06	0.05	
agricultural troubles at household level (dummy)	0.04	0.10	
household size	-0.05	0.02	*
indigenous language spoken in household (dummy)	-0.42	0.16	**
English speaker in household (dummy)	-0.64	0.39	†
grandparent migrated within Mexico (dummy)	0.00	0.13	
grandparent migrated to U.S. (dummy)	0.08	0.16	
inverse Mills ratio	6.08	2.10	***
# observations	216		

Significance codes: † 10% level, * 5% level, ** 1% level, and *** 0.1% level

Table 5b. Selectivity-Corrected Results for Level of Livestock Investment

Dependent variable is level of livestock investment (100,000 pesos)			
	Coefficient	Standard Error	
lagged predicted income from agricultural home production (pesos)	1.02	0.13	***
lagged predicted income from wage work (pesos)	-0.06	0.10	
lagged predicted income from remittances from within Mexico (pesos)	0.66	0.77	
lagged predicted income from remittances from U.S. (pesos)	-0.27	0.16	†
household land holdings (hectares)	0.00	0.00	†
Progresa transfers (100,000 pesos)	-0.16	0.37	
PROCAMPO transfers (100,000 pesos)	-0.66	0.48	
local within Mexico migration rate	-0.02	0.15	
local U.S. migration rate	0.04	0.09	
median wage in village (pesos)	0.00	0.00	
share of village land that is irrigated	0.16	0.04	***
share of village land held with secure property rights	-0.10	0.07	
share of village land with good soil	-0.24	0.06	***
number of adults in household with secondary education	0.02	0.01	†
number of adults in household with primary education	0.00	0.01	
agricultural troubles at household level (dummy)	-0.02	0.05	
household size	0.00	0.00	
indigenous language spoken in household (dummy)	-0.02	0.04	
English speaker in household (dummy)	-0.18	0.12	
grandparent migrated within Mexico (dummy)	0.07	0.05	
grandparent migrated to U.S. (dummy)	0.00	0.06	
inverse Mills ratio	-0.40	0.63	
# observations	512		

Significance codes: † 10% level, * 5% level, ** 1% level, and *** 0.1% level