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Migration and the Sending Economy: A Disaggregated Rural Economy Wide Analysis

by

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Abstract

Most economic research on migration impacts in source economies focuses on the households that send migrants and receive remittances, ignoring linkages that transmit migration's influences to others in local and regional economies. This paper offers an alternative, disaggregated economy wide perspective on migration and its impacts. It presents and illustrates a methodology to understand not only migration's effects on migrant-sending households, but also the ways in which these households transmit influences of migration to others in the source economy, via local market linkages. Data from the 2003 Mexico National Rural Household Survey are used to calibrate a series of interacting rural household models nested within a general equilibrium model of the whole rural economy. This modeling approach combines the strengths of micro models focusing on rural households with economy wide models, which highlight economic linkages among economic actors but traditionally have been implemented at an aggregate (national or multi-national) level. It explicitly takes into account the market structures that govern economic interactions and promote or retard the spread of migration effects within sending economies. Simulations reveal that the impacts of international migration and remittances on sending areas may be positive or negative and depend critically on the ways in which local markets transmit impacts among households.

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Migration and the Sending Economy: A Disaggregated Rural Economy Wide Analysis

Rural out-migration is at the heart of the economic development process (Lewis), and migration is the principal mechanism through which households in less developed countries (LDCs) become inserted into the international economy. A significant social science literature addresses interactions between migration and development in migrant-source areas (Massey, et al., 1998; Taylor and Martin, 2001). The centerpiece of economic research in this area is the new economics of labor migration (NELM), which conceptualizes the migrant as part of a larger social group, usually the family or household. The NELM provides a useful analytical starting point to understand how migration and remittances transform the economies of households with migrants in ways that were overlooked by previous migration research (see work by various authors in Stark, 1991).

The basic premise of this paper is that we need to go beyond a focus on migrant households in order to understand the complex ways in which migration reshapes migrant-sending economies. Households, like migrants, are part of larger social groups, e.g., communities, regions, and nations. Through their market interactions, migrant households transmit the impacts of migration to others within these groups. Non-migrant households become affected by migration through their interactions with migrant households—or with households that interact with migrant households, etc. Because of this, a household does not necessarily have to have a migrant in order to be affected by

migration. In fact, it is possible that most of migration's impacts on sending economies are found outside the households that send the migrants and receive the remittances.

This paper proposes a disaggregated economy-wide modeling approach to explore the direct and indirect influences of migration in migrant-sending regions and then uses this approach to study the impacts of migration under alternative market scenarios. The model is calibrated using data from a nationally representative survey of households in rural Mexico. Our findings illustrate how survey data and new modeling techniques can permit the analysis of migration impacts previously overlooked by migration research. They also reveal the sensitivity of international migration's impacts to local market conditions and differences in the effects of migration and remittances in the short and long runs.

In general, market integration in migrant-sending areas mutes and dissipates the impacts, both positive and negative, of migration and remittances. In one scenario that we explore, the rural economy is characterized as a collection of interacting agents like those characterized in the staple agricultural household model of Singh, Squire and Strauss (1986). All markets, including those for labor and capital, are assumed to be perfect, and all households are price takers. In this arguably unrealistic market environment, negative impacts of migration are minimal, and positive impacts are limited to remittances' contribution to household budgets, that is, a direct transfer effect.

In a more realistic scenario, rural wages are endogenous and affected by migration-induced shifts in the rural labor supply. Upward pressure on rural wages creates negative "lost labor" effects of migration on rural production activities, particularly those most intensive in labor. The existence of rural nontradables ads a new set of potential migration impacts, as changes in supply and demand alter the prices of these goods and services.

Migrant remittances potentially generate both short and long run production and income effects. In the short run, remittance-induced changes in demand may influence prices of nontradables. This transmits the effect of remittance transfers to production, as higher prices stimulate production of nontradables (possibly at the expense of tradables) and nominal (but not necessarily real) incomes in rural households increase. If remittances are not sufficient to counterbalance negative lost-labor effects of migration on production, rural general-equilibrium price effects will tend to reinforce negative lost labor effects on production.

In the medium to long run, income gains from migration may loosen liquidity constraints on investing in production activities if rural capital markets are imperfect—that is, if households have to self-finance their investments. In the inter-temporal version of our model, investments in one period are permitted to increase capital stocks in future periods. This usually (but not always) stimulates production and incomes, as posited by NELM research (e.g., Stark, 1991).

Remittances represent a direct effect of migration on rural household incomes. When a policy or market shock, e.g., currency devaluation or an increase in destination wages, stimulates remittances, the direct effect on incomes in migrant-sending areas is positive. Indirect effects include general-equilibrium wage and price effects, dynamic investment effects, and the migration response to both the initial shock and its wage, price and investment ramifications. Our findings suggest that these indirect effects are likely to be substantially larger than the direct effects on which researchers and policy makers tend to focus.

The rest of this paper is organized as follows. Part 1 briefly summarizes the new economics of migration perspective, and it motivates and proposes the use of a disaggregated economy wide modeling approach to explore the likely impacts of migration in rural economies. Part 2 presents the model. In Part 3 the model is used to simulate the effects of changes in international and internal migration under alternative rural market scenarios. Conclusions appear in Part 4.

1

Migration and the Transformation of Migrant-Source Economies

The Transformation of Migrant Household Economies

Typically, migrants do not sever their ties with the source household after they migrate. Family members who remain behind (often, parents and siblings) may reorganize both their consumption and production activities in response to the migrant's departure, and migrants (often, children) typically share part of their earnings with their household of origin, through remittances. Continuing interactions between migrants and rural households suggest that household-based approaches are more appropriate than individual-level models of migration decisions. Indeed, in individual-focused migration models, there is no rationale for migrants to share their earnings with the place of origin; we are left with the puzzle of why geographically extended families are prevalent in LDCs but less so in high-income countries (Rosenzweig, 1988) and few insights into the likely impacts of migration and remittances on source economies.

In what has become known as the new economics of labor migration (NELM; see Stark, 1991 and Stark and Bloom, 1985) view, migration decisions are not entirely the domain of individuals. They take place within a larger context—typically the household, which potentially consists of individuals with diverse preferences and differential access to income—and they are influenced by this social milieu. The perspective that migration decisions are not taken by isolated actors but by larger units of related people, typically by households or families, is a trademark of the NELM. So is the contention that people act

collectively not only to maximize income, but also to loosen constraints on investment that are created by a variety of market failures, including missing or incomplete capital, insurance, and labor markets. That is, migrants play the role of financial intermediaries in imperfect-market contexts, which characterize most of the world's rural economies

A number of studies find evidence in support of the basic tenets of the NELM (Lucas, 1987; Taylor, 1992; Rozelle et al., 1999, Taylor et al., 2003). A study of migration from households in rural Chin found that, in almost all production activities, the loss of labor to migration reduced net income. However, migrants generated remittances, and remittances, in turn, significantly increased net incomes in both farm and self-employment activities.

Household-focused studies provide an incomplete picture of migration-development interactions, overlooking influences of migration beyond the migrant-sending and remittance-receiving household.

Beyond Migrant Households: The Transformation of Migrant-Source Economies

Nearly all economic research on migration focuses on households. However, households are part of larger economies, of communities, regions, and nations. Migrant households' interactions within these economies project migration's impacts to other households. For example, if a migrant household uses remittances to finance a new project in the village, it may demand labor from another village household. If the migrant-sending household had not participated in migration, it would not invest in the

project, and the other household would not have a market for its labor (or other goods or services) in the village. Investing may not be limited to the migrant household, if there is some kind of local credit market (formal or informal) to channel savings among households. For example, a household that does not have a migrant in the United States could borrow from a household that obtained capital from migrant remittances.

Many or possibly most of the impacts of migrant remittances on migrant-sending economies may in fact lie outside the households that send migrants and receive remittances; demand linkages create income multipliers and transmit impacts of remittances from remittance-receiving households to others in the local economy, and ultimately, to regional commercial centers. These income growth linkages, in turn, shape future migration.

Migration may unleash a variety of other general-equilibrium effects on migrant-sending economies. For example, if the loss of labor to migration drives up local wages, rural economies may restructure themselves around labor scarcity, shifting to less labor-intensive (and more capital-intensive) activities and production technologies.

Access to markets shapes the interactions, direct or indirect, between migrant and other households in source economies. Access to a foreign or domestic migrant labor market is a prerequisite for migration to happen in the first place. The existence of local markets creates the possibility for linkages to transmit impacts from households with migrants to others in the sending economy. High transaction costs do the opposite. For

example, high costs of migrating—due to lack of information, etc.—inhibit some households from sending migrants abroad or to domestic urban centers. High costs of transacting in product markets limit the ability of households to market their output or obtain inputs. Missing or incomplete credit markets prevent capital from being channeled to its most efficient uses in rural areas and constrain rural households to self-finance investments; e.g., in the NELM, the same household that does the migrating must also do the investing.

Imperfections in rural commodity and factor markets may affect migration-development interactions negatively in some cases, positively in others. For example, high transaction costs in regional or national markets for goods or labor limit the possibilities for rural areas to benefit from regional trade integration, possibly intensifying migration pressures. However, they also create local market linkages that transmit migration's impacts—both positive and negative—to others in sending areas, namely, those who supply to the "protected" local market. For example, a migration-induced shift in labor supply may drive up wages in migrant-sending villages, benefiting wage earners. Higher incomes in migrant households increase the demand for services, pushing up prices and creating benefits for suppliers of the service (to the detriment of consumers). If high transaction costs isolate households from low prices in regional grain markets, grain farmers capture rents by producing for local demand. Migration, which injects new income into the local economy through remittances, may increase the demand for grain—for human consumption, feed for livestock, etc. This may create income gains for local grain farmers. Lack of access to regional credit markets may adversely affect

investment in rural areas while creating rents for local moneylenders—possibly including individuals with migrant remittance savings.

If migrants play the role of financial intermediaries who obtain capital in the form of remittances for their households, then rural capital market imperfections may result in "too much" migration. More generally, imperfections in rural markets for goods, factors, credit, insurance, etc., may intensify pressures for out-migration.

The importance of transaction costs and market structure is recognized by some micro-economic studies of household-farm economies (de Janvry, Fafchamps, and Sadoulet, 1991; Strauss, 1986; Rozelle, Taylor, and de Brauw, 1999), which explore household behavior in the absence of selected markets. Recently, a nascent body of research has begun to explore local impacts of policy changes using disaggregated or "micro" economy-wide modeling techniques (Dyer, Boucher and Taylor, 2006; Taylor, Yúnez-Naude, and Dyer, 2005). These studies take into account the ways in which agricultural households and firms interact in local markets, even when high transaction costs isolate them from larger, regional and global markets.

Understanding direct and indirect interactions between migration and development in migrant-source economies requires an approach that goes beyond the traditional household focus, elucidating market structures and the complex linkages that connect households within the regional economies of which they are part. Part 2 presents a disaggregated economy wide modeling approach designed for this purpose.

2

The Model

Understanding the impacts of migration in migrant-sending economies requires understanding micro responses, the complex linkages among economic agents within the economy, and the linkages between the rural economy and the outside world. Most economic research on rural economies entails the microeconomic modeling of individual agents' economic behavior, in most cases the behavior of agricultural households. However, that approach misses the linkages among economic agents that indirectly integrate rural people into global markets.

The modeling approach used in this study "nests" individual micro models of four rural household groups into a general equilibrium model of the whole rural economy. The households in the model include: (1) landless rural households; (2) subsistence and infra-subsistence household farms with fewer than 2 hectares of land, typical of small-scale, low productivity agriculture, frequently operating under marginal conditions and incomplete markets; (3) medium-holder (2-5 hectares) commercial household-farms, and (4) large-holder (more than 5 hectares) commercial household-farms. This typology works well to describe the socioeconomic landscape of rural Mexico.

The Household Models

Agricultural household models are the building blocks of the disaggregated rural economy-wide model. In aggregate CGE models, households receive income by selling their labor and other factors to shared production activities, and they spend this income

on consumption goods. In our disaggregated model each household type has its own production technologies and expenditure demands. The disaggregated model includes four different technologies to produce maize, from subsistence farmers using ox-and-plow technology to relatively capital-intensive commercial farmers. Not only do these households use different technologies to produce maize; they also are engaged in other production and labor market activities that vary from one household to another. They have different access to domestic and/or international migration, reflecting findings of past migration research that access to migrant destinations is network-driven and household-specific (e.g., see Massey, 1987; Taylor, 1987).

Households are assumed to maximize their utility from consumption goods, both home-produced and purchased, subject to cash income, technologies, time, access to migration, and self-sufficiency constraints that set consumption equal to production for subsistence maize households. The solution yields a set of demands for labor and land inputs into each activity, including migration, and consumption demands. For tradable goods and factors, prices are set by outside markets. For nontradables, prices are exogenous to individual households but determined by the interaction of supply and demand in rural markets. Endogenous rural prices result when transaction costs are high outside but not within the rural economy. In our model there are two such prices: wages and prices of nontradable services. As in the textbook model (Singh, Squire and Strauss, 1986), land is a fixed input and thus implicitly has a shadow price that varies across households.

General-Equilibrium Effects

General-equilibrium closure equations at the levels of the household and rural economies determine the (net) marketed surplus of tradable commodities as the difference between supply and demand. Prices for tradables are exogenous (marketed surplus from both individual households and the rural economy is endogenous). They are determined by markets outside the rural economy (e.g., world markets) or by policy. Prices of rural nontradables are endogenous. They satisfy local market-clearing conditions (rural marketed surplus is zero), and individual households are price takers within the rural economy (household marketed surplus is endogenous).

It might be argued that there is an active labor market in rural Mexico linked to internal and international migration. However, significant variation in the agricultural wage across the countryside suggests the existence of market imperfections generating local wages or at least wage rigidities. Access to migrant labor markets is not uniform; it is geographically concentrated and shaped by networks of family contacts at migrant destinations and other local and household-specific variables (Munshi, 2003). Daily agricultural worker wages in Mexico ranged from 50 to 140 pesos in summer 2002.[1] Lacking a regional focus, we cannot explicitly model these wage variations. Nevertheless, some of our market scenarios reveal the sensitivity of migration impacts to assumptions concerning how rural wages are determined.

[1] Analysis of Mexico National Rural Household Survey (ENHRUM) data, described below.

The solutions yield, for each household group, a set of core equations for outputs, input demands, migration, consumption demands, and either rural prices (for nontradables) or marketed surplus (for tradables). In the case of goods, marketed surplus is output minus household consumption. In the case of labor, it is the household's labor demand minus its labor supply, or net wage-labor supply. All of these variables are functions of the household characteristics used to construct the four household groups, as well as of exogenous market and policy variables (prices of tradables, the peso-dollar exchange rate, and government transfers). The base model reproduces a social accounting matrix (SAM) for each household group as well as for the whole rural economy. Once these base models are created, they are the starting point for each of our policy experiments, reported below. The equilibrium structure of the model insures that, once the model adjusts to a policy or market shock, the new solution will also produce a consistent set of SAMs.

Potential impacts of migration in the model are complex because of the interacting agricultural households, each with its own production technology, market access, and consumption demands. They reflect direct effects (i.e., the contribution of remittance transfers to household incomes) as well as indirect effects that result from the interactions among migration, remittances, wages and prices. Signing as well as quantifying the total impacts of migration and remittances on sending economies, therefore, cannot be done analytically; it requires a programming approach.

A summary of equations in the model appears in the Appendix.

Data

The model was calibrated using data from the 2003 Mexico National Rural Household Survey (*Encuesta Nacional a Hogares Rurales de México*, or ENHRUM). This survey provided detailed data on assets, socio-demographic characteristics, production, income sources, and migration for a nationally representative sample of rural households surveyed in January and February 2003. INEGI, Mexico's national information and census office, designed the sampling frame to provide a statistically reliable characterization of Mexico's population living in rural areas, that is, in communities with fewer than 2,500 inhabitants. For reasons of cost and feasibility, populations in hamlets or disperse populations with fewer than 500 inhabitants were not included in the survey. The result is a sample that is representative of more than 80 percent of the population that the Mexican government considers as rural.

Detailed data on household-farm production, wage work, and migration make it possible to estimate net activity incomes for each household in the sample, including from crop, livestock, commerce, nonagricultural activities (composed of handicrafts, village nonfarm enterprises, small-scale food processing, and various other home-based production activities), services, wage labor (agricultural and nonagricultural), and migration (internal and international), as well as from public transfers (PROCAMPO subsidies for basic grain producers and PROGRESA welfare payments). This list of incomes is exhaustive; the sum of income from the twelve sources equals household total net income.

Net incomes from production activities were calculated as the gross value of production (using observed local prices) minus purchased inputs. Gross income from livestock production was estimated as the change in value of standing herds between the end and start of the survey year, plus sales of animals and animal products and home consumption of home-produced animals and animal products, minus livestock purchases and input costs (feed, medicines, and other costs). Hired labor is rarely observed in livestock production. In the few cases where it was observed, it was included as a production cost when estimating net family income. Incomes from nonagricultural production activities were estimated in a manner analogous to net crop income (as gross value of production minus purchased input costs). Calculated in this way, net incomes represent total family value added in each activity. Migrant remittances were summed across all remitters and, in the case of dollar-denominated remittances from the United States, transformed to pesos using the prevailing exchange rate.

Table 1 presents summary statistics for each of the four household groups in our model. Households in rural Mexico on average have just under 4 members, including 0.6 children 12 years or younger. Average schooling of household heads is 4.5 years; however, schooling of children is higher than this; thus, the average for all household members is 5.5 years. Sixteen percent of rural households had at least one family member (head, spouse of head, or child of head or spouse) working in the United States in 2002. Twenty six percent had an internal migrant. Average landholdings were 4.8, hectares but with a large standard deviation (25.1), reflecting a high degree of landlessness.

Landed households tend to be slightly larger than landless households (see bottom 4 panels of Table 1). They also tend to be younger and more educated. The age of the household head ranges from 48.6 to 55.6 years in the three landed groups, compared with 45.3 in the landless group. Average schooling of household heads is 3.6 to 4.0 years in the landed households compared with 5.0 years in the landless. Migration propensities are slightly lower in landless than in landed households. The percentage of households with at least one migrant in the United States is 14.4% for landless and 16.2% for all households. The percentage with an internal migrant is 20.4% for landless and 25.7% for all households. The wealth index, centered on zero for the full sample, is slightly larger for landless households (0.43).

Incomes in rural Mexico are highly diversified (see Table 2). Most rural households engage in crop production. However, the share of net income from crop production in total income ranged from less than 1% (for landless households) to 15.3% (for the largest landholding group). Livestock accounted for another 0.9% to 6.9% of total rural income. Most agriculture and livestock-producing households also received income from several other sources, including wages, migrant remittances, public transfers, and non-agricultural production. By far the largest rural income share was from wages (43.1% to 64.1%). Only 13% of wages were from agricultural work, reflecting rural households' integration with non-agricultural labor markets. Remittances from international migrants accounted for between 6.4% and 11.2% of rural income. Internal-migrant remittances accounted for 2.1% to 7.2% of income. Households in rural Mexico received between 2.1% and 11.1% of their income from government transfers.

The largest share went to the largeholder group, who are major beneficiaries of Mexico's PROCAMPO program. The largest share accrued to the landless group, consisting mostly of PROGRESS welfare payments.[2] Rental income constituted between 3.4% and 4.4% of total income for the landed groups but was negligible for the landless group.

From Table 2 it is evident that income sources vary sharply across the four household groups. Predictably, the share of total income from crop production activities is highest for largeholder households. In contrast, the smallholder and landless households receive most of their income from wage work, mostly off-farm. The share of both international and internal migrant remittances is highest for the middle landed household group. Technologies and expenditure patterns also vary across household groups. Factor intensities are reflected in factor shares of value-added. In general, the largeholder households have the highest capital value-added shares in staple and cash-crop production.

These household expenditure patterns are critical in shaping the size and direction of consumption and investment demand linkages in Mexico's rural economy. Large budget shares for locally produced goods create a potential for household income changes to stimulate local production activities. For nontradables, local prices transmit changes in demand to production activities. For tradables, prices are determined in markets outside

[2] The PROCAMPO program replaced price supports with direct subsidy payments to basic grain producers, to facilitate the transition from price supports to freer and more open international markets. PROGRESA gave needs-based payments to poor rural households.

the local economy. Thus, local demand does not affect production, but it does determine the size of the net surplus available to outside (e.g., urban or export) markets.

Table 3 reports expenditure shares by household group. The budget share of home-produced crops is minimal for landless households (0.5%) and highest for the small-holder group (13.0%). The share for home-produced livestock products ranges from 1.0% (landless) to 3.3% (large-holder). To the extent that landless households consume crop and livestock products, they do so primarily by purchasing these goods in stores inside (commerce) or outside the village. Investments in education, housing, and other goods constitute up to one-fourth of total expenditures in rural Mexican households. The largest investments are on education, which represents between 7.6% and 12.5% of total budgets of the four household groups. The largest education share is in landless households, for which human capital is the key asset. Housing investments absorb between 2.7% and 4.8% of total expenditures, and other investments (savings and production) constitute between 5% and 6% in landless and smallholder households and between 9% and 10% in the two largest landholder groups.

All data were organized into a series of SAMs, one for each rural household group. These were then integrated into a rural sector "mega-SAM." The SAM provides the data input into the micro economy-wide, computable general equilibrium model.

Tradables, Nontradables, and Local Price Transmission

Goods or factors are tradables if outside prices are transmitted perfectly into the economy that is being modeled—in the present case, the rural economy represented by our model. Perfect price transmission requires well-functioning rural markets with low transaction costs. The extent to which outside prices are transmitted to rural household groups is empirical, ranging from perfect to nil. Goods or factors that are tradable for one household group may be nontradable for another (see de Janvry, Fafchamps and Sadoulet, 1991). When a good or service is tradable for a given household group, its price is determined either in rural markets or exogenously (e.g., in the world market).

To date, there has been little effort to test empirically for price transmission in rural economies (an exception is Rozelle, 2002). There is evidence, however, that imperfect price transmission results in endogenous rural prices as well as "shadow prices" of nontradables for some household groups. For example, in Mexico, where the government supported prices for basic grains in the 1990s, high transaction costs prevented most farmers from benefiting from this opportunity to sell to the government (e.g., see Dyer, et al., 2006). The extent to which price supports may have influenced local prices indirectly (e.g., through traders) is not known.

In our simulations we explore the sensitivity of impacts of international migration to assumptions regarding the structure of rural markets, specifically, how prices of factors, goods and services are determined. Four alternative market scenarios are considered. In Scenario I, all prices, including the rural wage, are assumed to be

exogenous, determined outside the rural economy. This scenario represents a rural economy-wide analogue to the perfect-markets agricultural household model that is a staple of microeconomic research (e.g., see Singh, Squire and Strauss, 1986). Scenario II assumes that all output prices are given but that the rural wage is endogenous. The rural wage, which is exogenous to each household, is determined endogenously by the interaction of the supply and demand of rural labor. In Scenario III, wages are exogenous but prices of rural services are determined endogenously, within the rural economy. For these nontradable rural services (from construction to haircuts), each household group is a price taker, but the rural market price of the service is determined endogenously, by the interaction of supply and demand. Scenario IV combines Scenarios II and III.

In all scenarios land is a fixed factor for all household groups. Most land in the surveyed households is *ejido* (reform-sector) land. Because land is treated as fixed, the rental rate is implicitly an endogenous shadow price that varies from household to household in the model.

The structure of the model permits us to explore the impacts of migration on production, incomes, and trade in a rural economy with diverse household activities and technologies. The four market scenarios make it possible to also explore the sensitivity of findings to market structures. Findings indicate that market structures are critical in determining both the sign and magnitude of international migration's impacts in sending economies.

Equations in the Model and Calibration

Each household model nested within the rural model has 5 components: household-farm (1) production, (2) income and (3) expenditures; (4) a set of general equilibrium closure equations, which insure that rural markets clear or else the rural economy is a net buyer ("importer") from or seller ("exporter" of marketed surplus) to outside markets, and (5) a price-determination component. For rural tradables, prices are exogenous. For rural nontradables (labor and/or services in Scenarios II-IV), prices are endogenous "equilibrium" prices, at which rural supply and demand are in balance.

To operationalize our model, a household version of a social accounting matrix (SAM) (Stone 1986; Pyatt and Round, 1979) was constructed from survey data for each household in the sample (the data are described in the next section). Data in the household SAMs were used to calibrate the individual household models. Each household model is in effect a CGE corresponding to the household group. Its factor and consumption demands depend on technology and preferences.

Cobb-Douglas production exponents in the household-specific production functions were set equal to measured factor shares in value added, as implied by profit maximization. This requires putting values on family inputs and on output, which is not always straightforward in the imperfect market environments characterizing LDC rural areas. The Mexico survey obtained information on the quantities of all factor inputs (land, family labor, hired labor, animal power, tractors and other physical capital) in crop

and noncrop production, and also on prices whenever market exchanges took place. Market prices were usually observed for intermediate inputs. The chief exception was maize seed, which usually was selected from the previous year's harvest. We valued seed and crop output at their prevailing local market prices. Valuing labor and tractor services (most households did not own their own tractor) is straightforward, using market prices. Most families used their own animal power in production; however, in a few cases animal services were hired, and we used the observed prices to value all animal capital inputs. Subtracting the costs of intermediate inputs, hired labor, and mechanical and animal capital services from the gross value of production yields a residual representing family labor and land value-added. Ejido land could not be rented at the time of the survey; this resulted in what essentially was a missing land rental market, which means that land rents had to be imputed to obtain land value-added. Family labor and land value-added shares were imputed econometrically, from regressions of total (land plus family labor) value-added from crops and livestock on land and family labor inputs.

Household-farm savings and expenditures were estimated using a linear expenditure system (LES) approach with no minimum required quantities (Deaton and Muellbauer, 1980). This specification implies that preferences are described by a Cobb-Douglas utility function. The parameters in the demand equations were set equal to measured budget shares for each household and each good.[3]

[3] The budget and factor shares for the subsistence good were obtained by valuing this good at a shadow price equal to its observed per-unit cost of production; see Becker (1965).

These relatively simple specifications for the production and demand functions are sufficient to demonstrate the transmission of migration effects in rural economies. They imply simple linear demand functions for inputs and consumption and are easy to estimate compared with more complex functions. Even when individual household-group responses are linear, aggregate outcomes of market shocks are nonlinear, shaped by households' production and demand parameters and endogenous prices.[4]

Many households received remittances from migrants in the United States or from internal migrants, mostly in nonfarm jobs. Aggregate CGE models assume that migration occurs until wages at the migrant origin and destination equilibrate (or that the disparity in wages remains the same before and after the policy shocks that the researchers simulate in their models). From a micro household-farm point of view, this is the wrong migration condition to impose. Households may allocate their members' labor either to local production (obtaining the value of the marginal contribution of the member's labor to local production) or else to migration (obtaining migrant remittances). We estimated remittance elasticities econometrically, from a regression of the log of households' migrant remittance receipts (net of amortized migration costs) for households that participated in migration on the log of their labor allocated to migration, controlling for family migration networks and correcting for potential sample selectivity bias. These

[4] We have found the results of policy experiments using similar models to be robust with respect to how we specify functional forms, including more complex production and expenditure functions with assumed elasticities. This is not surprising, inasmuch as the model is always estimated at the same point given by the survey data, and policy experiments involve marginal changes in exogenous variables.

elasticities were allowed to vary across household groups in the village-town model, reflecting differences among households in access to foreign and domestic migrant labor markets. The "migration equilibrium" condition in our model is that the value of the marginal product of labor in rural production activities equals the marginal effect of migration on remittance income (and the rural wage).

Equations in the village-town model are summarized in the Appendix.

3

Rural Economy-wide Impacts of Migration and Remittances

Estimated influences of migration on local economies depend both on the structure of markets, which transmit influences among households, and on whether these influences are considered in the short or long run. We begin by simulating the short-run effects of a 10% increase in the economic returns from internal and international migration on the rural Mexico economy under each of the three market scenarios. We then explore the long-run effects of migration, using a multi-period model. The difference between these two sets of simulations is that the second is designed to capture dynamic impacts of migration via investments, as posited by the new economics of migration. Most of the short-run impacts involve adjustments of local production to lost migrant labor (in Scenarios II and IV), to changing output prices (in Scenarios III and IV), and to increases in household income, through remittances and the new demand for locally supplied goods and services that they stimulate (in all scenarios).

Rural Economy Wide Impacts of Migration in the Short Run

Tables 4 and 5 report the short-run effects of a simulated 10% increase in the economic returns from Mexico-to-U.S. migration, as might result from currency devaluation or an increase in wages or employment for migrants in the United States. This simulation was carried out by increasing the shift parameter in the foreign remittance functions by 10%. It produces three sets of effects on the rural economy. The first is a direct transfer effect on the households that send migrants abroad: remittances by migrants already abroad increase by 10%. Second, there is an allocation effect, as higher returns from international migration encourage households to shift more labor into international migration (and away from other labor activities that compete with international migration). Third, where permitted (in Scenarios II, III and IV), changes in labor availability and higher remittances influence wages and the prices of nontradables, and this creates general-equilibrium effects on production, incomes, and investments by households that do not send migrants to the United States. A large part of these effects leak out of the rural economy, via linkages with outside (regional) markets in Mexico. Although the initial impacts of the migration increase are in households with migrants, the rural economy-wide model captures the transmission of these impacts from migrant to non-migrant households in the local economy, as well as to the rest of Mexico, through trade.

Local demand linkages depend critically on the degree to which the migrant-sending households are integrated with outside markets. With high levels of outside-market integration, as in Scenario I, the loss of family labor to migration stimulates the

demand for labor substitutes, and remittances stimulate household demand for market goods. However, rural wages and prices are not affected, because they are assumed to be determined in outside markets. The more closely integrated households are with outside markets, the more the impacts of remittances are diffused to those markets and the smaller the impacts on household production. In the case of a micro-economic model of pure commercial agricultural household that is a price taker in all markets, as in Singh, Squire and Strauss (1986), migration and remittances do not have any effect on production, by assumption. Scenario I depicts this perhaps extreme case. In scenario II, where the rural wage is endogenous, migration may influence production in all households via an increase in wages. This general-equilibrium effect is ignored by most microeconomic models of agricultural households.[5] In the presence of rural nontradables (e.g., services), migration and remittances may have more extensive effects on production as well as on consumption, and the sign of these effects is ambiguous. These effects are explored under Scenarios III and IV. In any household that does not have access to perfect credit and insurance, migration also may have important effects on production in the long run, via investments. Dynamic effects are explored in our inter-temporal simulations (see next section).

Under Scenario I the effects of the 10% increase in returns to international migration are unambiguously positive for income and nil for production. The direct transfer effect of remittances (that is, ignoring the migration response) increases the average real income of landless households by 75.5 pesos, or 0.83%; of smallholder

[5] One of the few exceptions is Braverman and Hammer (1984).

households, by 101.6 pesos (1.22%);of medium holders, by 109.0 pesos (2.06%), and of large holders, by 93.6 pesos (1.14%; see Column A in Table 4).

The migration effect is slightly larger than the direct transfer effect (Column B). It raises real incomes in the four groups by another 334 pesos (in small holder households) to 414.7 pesos (in medium holder households). The total direct transfer plus migration effects range from 429.5 pesos (in landless households) to 523.7 pesos (in medium holder households). Higher income stimulates the demand for village-produced food (by 5.3%) and nonfood (4.9%) items, as well as for tradables purchased outside the village, primarily in nearby commercial centers (by 4.8%). It also increases rural households' investments (by just under 5%), more than half (5.13%) are in education and health, 24.2% in housing and 16.4% in livestock.

Table 5 summarizes production effects under the four scenarios. Under the assumption that all rural prices are fixed, there are no linkage effects in Scenario I. With all rural prices fixed, no influences of migration or remittances are transmitted to production. The absence of production effects under Scenario I in Table 5 illustrates that the separability property of the staple agricultural household model carries through to the entire rural economy in an economy-wide model that nests within it a series of perfect-markets household models. This would be true even if some households were subsistence producers, as shown by Holden, et al. (1992). Mathematically, when all prices are given, none of the first-order conditions for profit maximization in rural production activities changes as a result of either the loss of labor to migration or

households' receipt of remittances. The only effects of international migration under this scenario are on the income and consumption side.

In Scenario II, international migration has linkage effects on production (Table 5), but these are all negative because migration competes with local production activities for labor, bidding up the rural wage. The rural wage increases by 5.5%. With all output prices fixed, all goods and services are tradable by assumption under Scenario II. This means that output prices do not increase to compensate for the rising cost of labor inputs, and production in all activities falls.[6] The production activities most adversely affected are those most intensive in family and hired labor. Crop and nonagricultural production contract by 6.5% and 3.7%, respectively. Livestock output falls only slightly (by 0.5%), due to its limited use of labor. The negative impacts of labor "lost" to migration on local production mirror findings from past econometric studies, which focus on households and do not take into account general equilibrium effects (e.g., Lucas, 1987; Taylor, 1992 and Rozelle, Taylor and de Brauw, 1999). They reflect a rural economy-wide analogue of the "Dutch disease," under which production of tradables contracts as labor is channeled into an export activity, in the present case, migration. The most labor-intensive activity competing with international migration is internal migration, which decreases by more than 10%. Households "bring back" internal migrants to migrate abroad as well as to work for higher wages at home.

[6] A negative effect of higher wages on production is not inevitable in a model with diverse production activities. Households could respond to higher wages by channeling more resources into activities that are not labor intensive, and output in those activities could increase.

The contraction in production results in negative income effects for medium and large holder households (see Table 4, Column D). The general-equilibrium wage ("Linkage") effect reduces these households' incomes by 96.6 and 40.2 pesos, respectively. However, higher wages exert a positive effect on the incomes of landless and small holder households. For the latter, wage-linkage effects captured in Scenario II add 111.5 and 151.9 pesos of income, respectively. The total effect of increasing returns from U.S. migration remains positive and large for all groups.

In Scenario III, output prices of rural non-tradables change in response to household demand. This creates a positive stimulus for the activities that produce these non-tradables (Table 5). However, it produces a negative effect on real incomes of rural households that consume nontradables (Table 4, Column F). By maintaining the fixed-wage assumption of Scenario I, this simulation highlights the linkage effects of migration that can result from the presence of non-tradable goods and services in sending economies. The linkage effects under Scenario III in Table 5 are nil for crops and livestock, which by assumption are tradables. However, nonagricultural production increases by 1.6%. As remittances increase household incomes and the demand for normal goods, the prices of these nontradables increase, stimulating production. However, in real terms, the income effects of the increased price of nontradables are all negative, ranging from 17.9 to 31.1 pesos. The total income effect of increasing returns from international migration are still positive, but they are smaller than in the perfect markets scenario.

Confronted by higher prices for rural nontradables, households shift consumption to tradables, which comprise the bulk of "Outside Village Consumption" in Table 5. The latter increases by 6.4% in Scenario III compared with 4.8% in Scenario I. Conversely, village non-food consumption, which includes the nontradables, increases 2.8% in Scenario III and 4.9% in Scenario I.

The results of Scenario IV generally represent a mixture of those from Scenarios II and III. Increasing returns from international migration produce negative output effects for tradables (crops and, to a smaller extent, livestock), as in Scenario II. However, they have an effect on nonagricultural production that is positive, as in Scenario III, although smaller because of the negative wage effect. The effect on total real income is higher than in the perfect markets scenario for landless and small-holder households (492.8 and 532.8 pesos, respectively; see Table 4, Column I), reflecting the positive wage effect on these households' incomes. However, because of the higher cost of consuming nontradables, this real income gain is smaller than in the pure endogenous wage scenario (541.1 and 587.5 pesos). The reverse obtains for the medium and large holder households. Their total real income increases less in Scenario IV than in the other scenarios, reflecting the combined negative effects of higher labor costs and higher consumption prices. As migration increases, households reorient their demand towards markets outside the village.

The changes in investments reported at the bottom of Table 5 represent the link between modeling migration impacts in the short run and in the medium-to-long run, to which we now turn.

Impacts of Migration in the Medium to Long Run

Although migration tends to compete with local production in the short run, in the medium to long run migration and remittances may have additional impacts, by loosening constraints on investments in new and existing production activities (Stark, 1991; Taylor and Adelman, 1996; Massey, et al., 1998). To explore these medium-to-long-run production effects, we turn the short-run model into a multi-period model in which migration-induced changes in investments in the short run map into changes in household capital in a future period. We then solve the two-period model and compare the results to those presented above. Specifically, the increases in investment on livestock and other items reported in Table 5 are used to update fixed capital in each of the household production functions. For example, livestock investments increase the stock of (animal) capital in the production functions for livestock. This results in an increase in livestock output in the next period, which in turn produces new rural economy-wide effects, new investments, and new rounds of stimulus to the economy in future periods. We carried out this simulation over five periods (years). The short-run impacts reported in Tables 4 and 5 still obtain. The findings reported in Table 6 are the additional simulated dynamic investment effects of the one-time 10% increase in returns from international migration, after 5 years. They represent a complex interaction among investments in new capital (in

all scenarios) and resulting influences on rural prices over time (in Scenarios II through IV).

The dynamic model does not consider other investment effects. One of these is schooling, the investment that increases most in the static migration experiment (see Table 5). Educational investments may have productivity effects on the farm. Schooling also has a positive effect on internal migration, which in turn produces new income in the form of remittances. The effects of schooling on migration are beyond the scope of the present study; however, they have been estimated econometrically elsewhere (e.g., Mora and Taylor, 2005).

All production activities benefit from the migration-induced investments (see top panel of Table 6). However, the largest dynamic effect of migration is on activities that make the greatest use of capital whose stock increases as a result of the change in investments. In all scenarios, the largest dynamic investment effect is on livestock production, which increases between 10.4 and 14.1 percent. Agricultural production increases between 5.7% and 9.2%, while nonagricultural production, which in rural Mexico tends to be relatively labor intensive, increases between 3.7% and 7.6%.

The effect of new investments on rural wages is ambiguous, particularly when there are nontradables as in Scenario IV. In Scenarios I and III, as before, the rural wage is assumed to be fixed and thus is unaffected by new investments. In the endogenous wage scenario, a higher demand for labor from new production investments exerts upward

pressure on wages, which rise 1.2%, and both international and internal migration decrease (by 2.6% and 5.7%, respectively). In the combined endogenous wage and nontradables scenario (IV), the rural wage decreases slightly, with a slight positive effect on migration and also a slight positive production effect relative to Scenario II.

Clearly, the sector that gains the most from the dynamic investment effect is livestock. This finding echoes the results of micro-econometric studies that remittances promoted the accumulation of livestock over time and increased the rate of return to livestock assets, through complimentary investments (Taylor, 1992; Taylor and Wyatt, 1996).

Dynamic investment effects add an additional component of household income change to the ones presented in Table 4. The investment effect is usually, but not always, positive. In Scenario I, all households gain in real terms from the positive effect of new investments on production, given fixed prices. In Scenario II, as in the static case, the income effect is larger than in the fixed-wage case for the landless and small holder groups (188.7 and 115.7 pesos, respectively, compared with 125 and 52.7 pesos in Scenario I). These households benefit from higher wages induced by the increased demand for labor in rural production activities. The two largest land holding groups, for whom wages are more of a cost of production, enjoy smaller income gains when the wage is endogenous. When there are nontradables, whose prices increase as a result of new demand stimulated by investments, the dynamic income effect turns negative for the landless and small holder groups but remains positive for the two largest land holding

groups. Under Scenario IV, with both nontradables and an endogenous wage, only the landless households lose income as a result of the dynamic investment effect.

These findings illustrate the complexity of international migration's dynamic effects on real incomes in a rural economy where households are heterogeneous.

4

Conclusions

Some economic agents are affected directly by international migration, sacrificing labor to foreign labor markets but receiving remittances in return. These agents have complex economic interactions with others in the local, regional, and national economies of which they are part. Through these interactions, other agents are affected indirectly, and the economies of households, communities, and regions are transformed. Micro econometric studies focusing on households generally miss the interactions among households that shape migration's impacts.

This paper utilizes micro-economy-wide modeling techniques to explore the short-term and long-term impacts of international migration in rural Mexico. Simulation findings illustrate the complex ways in which international migration influences rural economies, stimulating some production activities while causing others to contract, and transforming the structure of the rural economy over time. The findings presented here illustrate the importance of indirect effects of international migration in sending economies. These include general-equilibrium wage and price effects as well as dynamic

investment effects. Past studies, including of impacts of remittances on income and inequality, consider only direct influences of changes in remittances, or the returns from migration, holding migration and prices constant and ignoring general equilibrium effects.[7] However, as evident in Tables 4 thought 6, direct remittance effects generally are small compared with indirect effects.

This analysis has important ramifications for development economics research, policy, and project evaluation.

Theoretical and empirical studies with an aggregate or macro focus on nations or groups of nations miss the ways in which migration and other phenomena play out in local economies, and they do not offer insights into how policies and development projects may influence this process. On the other hand, microeconomic models focusing on individual actors (individuals, households, or firms) are likely to miss many of the influences of migration, as well as the potential influences of public policies and development programs, on rural economies. Impacts on economic agents directly affected by migration or government policies are only part—and perhaps only a small part—of the story of how influences unfold within rural economies. Many other economic agents are influenced indirectly, through local market interactions, and they are a key part of the process by which migration transforms local, regional, and ultimately national economies.

[7] E.g., see the remittance an inequality studies reprinted in Stark (1991) and references therein.

The conclusion that directly affected agents transmit influences of migration to others has relevance beyond understanding how migration processes play out within nations. For example, project evaluation methods need to have an expanded vision that includes economic actors not directly affected by the project under consideration. Assessing the impacts of agricultural programs or policy reforms requires going beyond the households directly affected by those reforms. For example, "decoupling" schemes in Mexico, which replace food price supports with direct income payments to farmers, have impacts on the rural economy that extend beyond the households that receive crop subsidies. In fact, market imperfections in rural areas cast doubt on whether such transfers are truly "decoupled" from production, once the full impact of the transfers unfolds within local and regional economies. Rural education policies may create private benefits, to the households whose members' schooling increases, as well as social benefits, which unfold through these households' interactions with others in the rural economy. Technological change has both direct effects (on the adopting households) as well as indirect "social" effects (on households interacting with adopters through factor and commodity markets). By concentrating on directly affected economic actors, we may be looking for the impacts of policy, market, and other changes in the wrong places.

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Table 1: Summary statistics

(a) All Households (N=1,777)

Variable	Mean	Std.Dev.	Min	Max
Land	4.818	25.113	0	537.5
Size	3.953	1.960	1	13
Ahead	48.586	16.081	15	95
Edhead	4.470	3.742	0	20
Dusfam	0.162	0.369	0	1
Usfam	0.350	1.043	0	9
Dmxfam	0.257	0.437	0	1
Mxfam	0.701	1.573	0	10
Index	0.002	2.034	-6.282	4.483

(b) Landless Households (N=931)

Variable	Mean	Std.Dev.	Min	Max
land	0.000	0.000	0	0
size	3.838	1.928	1	13
ahead	45.313	16.026	15	95
edhead	5.008	3.992	0	20
dusfam	0.144	0.351	0	1
usfam	0.299	0.940	0	8
dmxfam	0.204	0.403	0	1
mxfam	0.578	1.462	0	9
index	0.432	1.695	-6.282	4.207

(c) Households with Fewer than 2 Hectares (N=249)

Variable	Mean	Std.Dev.	Min	Max
Observations	931			
Land	0.861	0.460	0.001	1.9
Size	3.972	1.964	1	13
Ahead	48.614	16.127	15	94
Edhead	3.578	3.307	0	16
Dusfam	0.112	0.317	0	1
Usfam	0.201	0.718	0	7
Dmxfam	0.313	0.465	0	1
Mxfam	0.679	1.289	0	7
Index	-1.399	1.904	-5.336	2.848

(d) Households with 2 to 5 hectares (N=240)

Variable	Mean	Std.Dev.	Min	Max
Observations	931			
land	3.143	0.982	2	5
size	4.438	2.091	1	13

ahead	50.750	14.239	18	84
edhead	3.975	3.349	0	17
dusfam	0.167	0.373	0	1
usfam	0.329	0.966	0	7
dmxfam	0.313	0.464	0	1
mxfam	0.788	1.611	0	8
index	-0.605	2.192	-6.282	3.661

(e) Households with More than 5 Hectares (N=357)

Variable	Mean	Std.Dev.	Min	Max
Observations	931			
land	21.268	52.920	5.25	537.5
size	3.916	1.906	1	11
ahead	55.650	14.856	17	93
edhead	4.025	3.376	0	18
dusfam	0.241	0.428	0	1
usfam	0.602	1.430	0	9
dmxfam	0.317	0.466	0	1
mxfam	0.980	1.931	0	10
index	0.268	2.282	-5.483	4.483

Table 2. Mexico Rural Household Incomes, By Source and Household Group in Model

Income Source	Household Group							
	Landless (pesos)	%	<1 Ha. (pesos)	%	1 to 4 Has. (pesos)	%	>5 Has. (pesos)	%
Agriculture	68.16	0.66	635.31	5.39	226.04	2.76	1642.91	15.30
Livestock	94.88	0.92	475.69	4.04	560.46	6.85	696.26	6.48
Services								
Commerce	696.83	6.76	519.93	4.41	694.95	8.50	374.10	3.48
Transportation	1072.83	10.41	0.00	0.00	7.10	0.09	0.39	0.00
Construction	16.67	0.16	58.71	0.50	0.60	0.01	108.92	1.01
Other	443.36	4.30	368.71	3.13	244.59	2.99	288.28	2.68
Wages	6603.91	64.09	7079.29	60.05	3960.14	48.42	4632.04	43.13
Rents	77.15	0.75	399.43	3.39	355.58	4.35	473.19	4.41
Migration								
International	747.85	7.26	758.35	6.43	911.80	11.15	781.24	7.27
Internal	215.07	2.09	701.63	5.95	590.23	7.22	509.46	4.74
Public								
Transfers	211.30	2.05	737.43	6.26	601.48	7.35	1196.07	11.14
Other	55.92	0.54	54.33	0.46	25.58	0.31	36.71	0.34
Total	10303.92	100.00	11788.83	100.00	8178.54	100.00	10739.58	100.00
Sample Size	931		249		240		357	

Exchange Rate in 2002: Approximately 10 pesos per U.S. dollar. Source: ENHRUM, 2003.

Table 3. Expenditure Shares, by Rural Mexican Household Group

Expenditure	Household Group (% of Total Expenditures)			
	Landless	<1 Ha.	1-4 Has.	>5 Has.
Consumption Inside Village				
Agriculture	0.48%	13.00%	8.78%	6.74%
Livestock	1.03%	3.24%	2.47%	3.29%
Services				
Commerce	16.93%	14.47%	20.44%	14.85%
Transportation	0.40%	0.34%	0.44%	0.37%
Construction	10.89%	5.18%	3.18%	4.82%
Other	6.11%	5.25%	5.89%	4.72%
Consumption Outside Village	42.41%	40.92%	34.23%	42.70%
Investments				
Education and Health	12.54%	7.62%	10.89%	10.31%
Housing	3.25%	4.82%	4.57%	2.71%
Other	5.96%	5.17%	9.10%	9.50%
Total	100.00%	100.00%	100.00%	100.00%
Sample Size	931	249	240	357

Table 4. Decomposition of Rural Economy-wide Income Effects of a 10% Increase in Returns to International Migration in the Short Run

Household Group	Market Scenario								
	I. Perfect Markets			II. Endogenous Wage		III. Nontradables		IV. Scenarios II and III	
	(A) Direct	(B) Migration Effect	(C) Total Effect	(D) Linkage Effect	(E) Total Effect	(F) Linkage Effect	(G) Total Effect	(H) Linkage Effect	(I) Total Effect
Change in Household Real Income (Pesos)									
Landless	75.47	354.07	429.54	111.54	541.08	-23.33	406.21	63.29	492.83
Small Holder	101.59	333.99	435.58	151.92	587.50	-21.78	413.8	97.27	532.85
Medium Holder	109.02	414.69	523.71	-96.63	427.08	-17.91	505.8	-178.60	345.11
Large Holder	93.6	355.13	448.73	-40.24	408.49	-31.08	417.65	-132.87	315.86
Total Rural	87.31	359.65	446.96	58.59	505.55	-23.94	423.02	-4.03	442.93
Percentage Contributions of Direct, Migration and Linkage Effects to Real Income Change									
Landless	17.57%	82.43%	100.00%	20.61%	100.00%	-5.74%	100.00%	12.84%	100.00%
Small Holder	23.32%	76.68%	100.00%	25.86%	100.00%	-5.26%	100.00%	18.25%	100.00%
Medium Holder	20.82%	79.18%	100.00%	-22.63%	100.00%	-3.54%	100.00%	-51.75%	100.00%
Large Holder	20.86%	79.14%	100.00%	-9.85%	100.00%	-7.44%	100.00%	-42.07%	100.00%
Total Rural	19.53%	80.47%	100.00%	11.59%	100.00%	-5.66%	100.00%	-0.91%	100.00%
Percentage Changes in Household Income									
Landless	0.83%	3.56%	4.39%	1.14%	5.53%	-0.49%	3.90%	0.65%	5.04%
Small Holder	1.22%	3.47%	4.69%	1.63%	6.32%	-0.60%	4.09%	1.04%	5.73%
Medium Holder	2.06%	6.21%	8.27%	-1.52%	6.75%	-0.84%	7.43%	-2.82%	5.45%
Large Holder	1.14%	3.79%	4.93%	-0.44%	4.49%	-1.05%	3.88%	-1.46%	3.47%
Total Rural	1.05%	3.86%	4.91%	0.64%	5.55%	-0.66%	4.25%	-0.05%	4.86%

Base Incomes (Pesos)		
	Per Household	**Per Capita**
Landless	9073.79	2364.20
Small Holder	8322.56	2095.31
Medium Holder	5298.55	1193.91
Large Holder	8216.09	2098.08
Total Rural	8286.33	2050.57

Exchange Rate in 2002: Approx. 9.7 pesos per US$.

Table 5. Simulated Effects of a 10% Increase in Returns from International Migration on Production, Wages, Migration and Expenditures in the Short Run

Outcome	Market Scenario			
	I. Perfect Markets	II. Endogenous Wage	III. Nontradables	IV. Scenarios II and III
Production (% Change)				
Crops	NA	-6.54	NA	-7.84
Livestock	NA	-0.55	NA	-0.67
Nonagricultural	NA	-3.71	1.58	0.09
Wages (% Change)				
Wages	NA	5.49	NA	6.68
Migration				
International	57.44	22.07	57.44	15.74
Internal	NA	-10.75	NA	-12.85
Expenditures (% Changes)				
Village Consumption				
Food	5.34	5.72	5.17	6.79
Non Food	4.87	5.58	2.79	0.33
Outside Village Consumption	4.85	5.5	6.36	11.95
Investments				
Total (% change)	4.95	5.55	4.95	7.05
Composition: % of New Investments Spent on…				
Education and Health	51.29%	52.06%	51.42%	52.58%
Housing	24.21%	24.09%	24.18%	24.02%
Animals	16.40%	16.62%	16.40%	16.51%
Other	8.09%	7.24%	8.00%	6.90%

Table 6. Rural Economy-wide Effects of a 10% Increase in Returns from International Migration in the Medium to Long Run

Dynamic Outcome	Market Scenario			
	I. Perfect Markets	II. Endogenous Wage	III. Nontradables	IV. Scenarios II and III
Production (% Change)				
Crops	7.72	5.74	9.2	9.01
Livestock	10.45	11.08	11.53	14.11
Nonagricultural	7.41	7.64	3.67	4.76
Wages (% Change)				
Wages	NA	1.25	NA	-0.31
Migration				
International	NA	-2.61	NA	0.67
Internal	NA	-5.74	NA	1.51
Incomes				
Landless	124.98	188.7	-164.6	-25.13
Small Holder	52.75	115.73	-35.7	90.14
Medium Holder	145.59	104.02	59.84	121.57
Large Holder	189.82	162.7	289.9	219.86
Total Rural	130.67	161.82	40.22	60.05
Expenditures (% Changes)				
Village Consumption				
Food	5.34	1.49	0.65	-0.46
Non Food	4.87	1.71	7.91	11.03
Outside Village Consumption	4.85	1.69	-6.05	-9.65
Investments				
Total (% change)	1.4	5.55	-0.24	-1.44
Composition: % of New Investments Spent on…				
Education and Health	20.78%	52.79%	87.27%	57.71%
Housing	9.20%	15.74%	22.14%	16.05%
Animals	36.12%	6.88%	-15.31%	3.74%
Other	33.90%	24.59%	5.90%	22.50%

Appendix
Summary of Equations in Rural Economy-wide Model

Households are assumed to maximize utility:

$$U^h = U^h(X_i^h) \qquad i = 1,...,I \text{ goods}$$

where X_i^h is the demand for good i by household h, subject to the following constraints:

(1) Cash Income:

$$\sum_{i \in tradables} P_i X_i^h = Y^h$$

where P_i is the price of good i and Y^h is the household's cash income, the sum of net income from production of tradables, wages, and factor remittances;

(2) Production Technologies:

$$Q_i^h = Q_i(FD_i^h, V_i^h)$$

Q_i^h is output of good i, FD_i^h is a (1xF) vector of factor inputs whose elements are $FD_{i,f}^h$; and V_i^h represents other, intermediate inputs;

(3) Time:

$$\sum_{i=1}^{I} FD_{i,f}^h + FS_f^h + MIG_f^h \leq \overline{T}_f$$

$FD_{i,f}^h$ denotes the demand for factor f in production activity i; FS_f^h is the household's factor supply to local markets; MIG_f^h is the amount of the factor allocated to markets outside the village (e.g., labor migration); and $\overline{T}_f$ is the household's total factor endowment;

(4) Remittance functions:

$$R_f^h = \phi_f^h(MIG_f^h)$$

First-order conditions for utility maximization include:

<u>Production and Migration:</u>

Marginal value product equals price for all factor inputs f:

$$P_i Q_{f,i} = w_{i,f}$$

where $w_{f,i}$, the factor price in activity i, equals one of the following: w_f, the local factor price for factors fixed in total supply in local economies but mobile across production activities and households (in our simulations, these factors include labor and land), or $\omega_{f,i}$, the household and sector-specific endogenous price of factors fixed by activity (capital).

Marginal remittances (the marginal value product of migration for the household) equals the wage w_f:

$$\partial R_f^h / \partial MIG_f^h = w_f$$

Consumption:

Marginal utility equals the marginal utility cost of consumption:

$$U_i^h = \lambda^h P_i$$

where λ^h is the marginal utility of income. Cash income constraints are binding:

$$Y^h - \sum_{i \in tradables} P_i X_i^h - \sum_{i \in tradables} P_i V_i^h = 0$$

For household nontradables, there are subsistence constraints of the form:

$$Q_i^h = X_i^h + V_i^h, i \in nontradables$$

These first-order conditions yield consumption-demand functions of the form:

$$X_i^h = X_i^h(\underline{P}, Y^h) \qquad i = 1,...,I \text{ goods}$$

where $\underline{P}$ is a vector of prices of all consumption goods, including shadow prices of nontradables.

Rural General-Equilibrium Constraints:

The general-equilibrium conditions include material-balance equations for all goods:

$$MS_i = Q_i - \sum_{h=1}^{H} X_i^h$$

where MS_i is net rural marketed surplus ($MS_i = 0$ for local nontradables); and equilibrium in rural factor markets:

$$FMS_f = \sum_{h=1}^{H} \left(FS_f^h - \sum_{i=1}^{I} FD_{i,f}^h \right)$$

$FMS_f = 0$ when local factor markets exist and determine factor prices. Finally, rural trade balance is implied by the other equations in the model:

$$\sum_{i=1}^{I} p_i MS_i + \sum_{h=1}^{H} R_f^h = 0$$