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Poverty Dynamics in Rural Mexico: An Analysis Using Four Generations of Poverty Measurement

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Abstract

Drawing on four generations of poverty measurement, this paper uses panel data from the 2002-2007 period to analyze rural poverty in Mexico. The results show that almost three fifths of the surveyed households experienced poverty at least once, while one fifth was persistently poor. While these standard poverty measures are informative, the key challenge is to determine who can expect to escape poverty over time. According to an asset-based expectation of household welfare, from 36% of households that were poor in 2007, 29% can expect to escape poverty over time and 7% structurally-poor households cannot. However, asset accumulation dynamics show that in the long term all households can expect to escape poverty because a single stable equilibrium was found at 6.35 times the food poverty line. Nevertheless, one should not be overly optimistic because this still represents an average rural individual living with 105 pesos per day.

Resumen

Basándose en cuatro generaciones de medición de la pobreza, este trabajo analiza la pobreza rural en México utilizando datos panel para el periodo 2002-2007. Los resultados muestran que casi tres quintas partes de los hogares encuestados fue pobre en al menos un periodo, mientras que una quinta parte fue persistentemente pobre. Si bien estas medidas estándar de pobreza son informativas, el desafío es determinar quién se puede esperar que escape de la pobreza en el futuro. De acuerdo con una expectativa del bienestar de los hogares basada en los activos que poseen, del 36 por ciento de los hogares que eran pobres en 2007, el 29 por ciento se puede esperar que escape de la pobreza a través del tiempo, mientras que el 7 por ciento restante representa hogares estructuralmente pobres que no podrán hacerlo. Sin embargo, la dinámica de acumulación de activos muestra que todas las familias pueden esperar escapar de la pobreza en el largo plazo debido a que se localizó un único equilibrio estable igual a 6.35 veces la línea de pobreza alimentaria. Sin embargo, no hay que tomar estos resultados con demasiado optimismo porque esto representa un promedio de 105 pesos por individuo al día.

Introduction

Recent results document the existence of a process of poverty alleviation in Mexico in the years following the Mexican 1994 economic crisis and prior to the 2007-2008 global financial crisis (see Cortés *et al.*, 2003; Székely, 2005; Galindo *et al.*, 2009). However, some regions of rural Mexico have failed to share in this process as a result of limited economic opportunities, social inequalities, poor education, and lack of productive assets. An important fraction of the poor population is indigenous and tends to be concentrated in sloping areas in southern Mexico and the Sierra Madre Occidental. The persistence of poverty among particular identifiable groups suggests poverty may be a long-duration self-reinforcing event so that the initially poor will stay poor. Then, a forward-looking approach to rural poverty analysis is required in order to measure not only the degree of current poverty but most importantly how many of the currently poor will likely remain poor in the future.

The purpose of this study is to analyze poverty dynamics in rural Mexico and to determine if certain subgroups are more likely than others to remain poor in the long run. In order to accomplish this objective we move beyond the measurement of poverty headcounts to incorporate the analysis of poverty transitions, distinguishing between structural and stochastic forms of transitory and chronic poverty through an asset-based disaggregation of expected welfare, and apply what is known as a fourth generation poverty measurement approach, based on an understanding of asset accumulation dynamics, to distinguish deep-rooted persistent poverty from poverty that decreases over time.

This paper is organized as follows. Section 1 describes the traditional approach to poverty measurement, then discusses the method to distinguish structural from stochastic poverty status through the use of a livelihood-weighted asset index, and finally introduces the theoretical background of poverty traps by briefly describing Carter and Barrett's (2006) threshold model of poverty traps and the intrinsic characteristics model. Section 2 introduces the data source and presents the estimation results describing the econometric methods that have been followed. Last section presents the conclusions of the analysis.

1. Four generations of poverty analysis

Following Carter and Barrett (2006) we apply four alternative approaches to poverty measurement. This allows us to obtain a better understanding of the characteristics of poverty in rural Mexico using panel data. A brief description of each one of these approaches is provided below.

1.1. The first generation

The first generation approach to poverty measurement relies on comparing household income or expenditure for a given point in time to a poverty line. The poverty line is broadly defined as the minimum level of income or expenditure that allows a household to cover its basic needs. The most commonly used first generation poverty measure is the FGT measure proposed by Foster, Greer and Thorbecke (1984). The FGT index is defined as:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{N} I_i \left(\frac{\bar{u}-u_i}{\bar{u}}\right)^\alpha \tag{1}$$

Where N is the sample size, $\bar{u}$ is the poverty line, u_i is the flow-based measure of welfare (income, expenditures, assets), I_i is an indicator variable taking value one if $u_i < \bar{u}$ and zero otherwise, and α is a parameter reflecting the weight placed on the severity of poverty. Setting $\alpha = 0$ yields the poverty headcount ratio P_0 (the share of a population falling below the poverty line). The higher-order measures, P_1 and P_2, yield the poverty gap measure (the money metric measure of the average financial transfer needed to bring all poor households up to the poverty line) and the squared poverty gap (an indicator of the severity of poverty that is sensitive to the distribution of well-being among the poor). As we progress from P_0 to P_1 to P_2, the FGT measure gets more and more sensitive to extremely low incomes.

1.2. The second generation

One of the main drawbacks of first generation poverty measures is that, even if there is panel data available allowing for the measurement of poverty over time using the same set of households, they are incapable of distinguishing if the same unlucky minority experiences poverty over time or if poverty is a purely transitory phenomenon. Based on panel data, second generation poverty measurement allows observing a set of households' poverty status in more than one period. By identifying who was poor in each of the periods following first generation measures, it is possible to decompose households into three categories: the always poor, the sometimes poor, and the never poor.

By this logic, households that are always poor are considered to be chronically poor while those that are sometimes poor are referred to as transitorily poor. To be sometimes poor means that the household has either got ahead (had income above the poverty line in period t having been poor in period t-1) or fell behind (income fell below the poverty line in t having been non-poor in t-1). The percentage of households that falls into each of these categories may then be conveniently presented as a poverty transition matrix. However, the observation of chronic poverty motivates the more forward-looking question of who is likely to remain poor into the future (Carter and Barrett, 2006). This question cannot be properly answered with this second generation approach.

1.3. The third generation

The main disadvantage of second generation measures is their inability to distinguish structural from stochastic poverty status. The goal of third generation measurement is to overcome income and expenditure's high limitations in both accuracy and measurement, due to high variability or seasonality, and introduce asset ownership, such as that of land and livestock, as a more accurate measure of wealth.

Carter and May (1999, 2001) set the framework for third generation poverty measurement by characterizing poverty in terms of the livelihood or claiming systems (e.g. wage labor, farming, owning a shop or a taxi) that link social and economic endowments to real income or consumption possibilities. This has allowed identifying the poor as those sharing common income-claiming strategies, entitlements, endowments and other characteristics related to how they generate their income and the stability with which they do it. Their reformulation of poverty measurement from income to asset space has introduced the concept of an asset poverty line, which is simply the level of assets that would map to a level of income equal to the income poverty line. In their model, households that own bundles of assets (land, livestock, machinery, etc.) above the asset poverty line should be able to obtain income above the income poverty line. However, there are constraints that may limit household's ability to effectively utilize their productive assets to generate income. This suggests that poverty is a matter of not only having few assets, but also of facing constraints which limit the effectiveness with which those assets can be used (Carter and May, 1999).

Based on households' ownership of physical assets and entitlements, third generation poverty measurement allows a household's asset-based expected level of welfare to be compared to the actual income they obtain. A household's low level of income may be defined as a stochastic or structural poverty phenomenon depending on whether their expected level of welfare based on the bundle of assets they own is located above or below the asset poverty line. For example, there may be households that own a great variety of assets, but obtain a very low income. Then, if such a household is obtaining a level of income below the income poverty line but their asset-based expected level of welfare is above the asset poverty line, then we would say this household's poverty is a stochastic phenomenon. Their income may have dropped because their business may have experienced adverse shocks, they may have had a bad harvest or someone in the family may have fallen sick. However, their level of wealth in terms of the things they own may have stayed the same. For other households, obtaining a low level of income may be consistent with their ownership of very few assets. For such households, the asset-based expected level of welfare is below the asset poverty line and income is also below the income poverty line. Then, these households' poverty is a structural phenomenon.

1.3.1. Construction of a livelihood-weighted asset index

The construction of a one-dimensional asset-based index that reflects a household's expected level of well-being is a key step for third generation poverty measurement. This section briefly describes the approach followed in this work to create a variable that summarizes a household's wealth measured by assets.

Constructing an index of asset wealth requires selecting a set of weights for each asset such as $A_i = \hat{\alpha}_1 a_{1i} + \ldots + \hat{\alpha}_K a_{Ki}$, where A_i is the asset index that results from adding assets $a_1,\ldots,a_K$ according to their assigned weights $\alpha_1,\ldots,\alpha_K$. The main discussion in the construction of an asset index is how to determine these weights instead of imposing them arbitrarily.

Recently, development economists have followed the recommendation made by Filmer and Pritchett (1998) to use principal component analysis (PCA) to aggregate several binary asset ownership variables into a single asset index.[1] However, Adato *et al.* (2006) and Naschold (2009) suggest a livelihood regression as a method for the construction of an asset index that offers a more intuitive interpretation of the index' units; that is the approach followed in this work.

[1] It is worth noting that because PCA was created for the aggregation of several continuous variables into a single one, the application of PCA to discrete asset variables has been criticized. Kolenikov and Angeles (2004) provide a technique that incorporates the use of discrete data into PCA. This technique named polychoric PCA has been proved to be superior to PCA.

A livelihood regression expresses a household's well-being as a function of its characteristics and asset holdings (Adato *et al.*, 2006). Let y_{it} be a household's real income and S_{it} its subsistence needs (in our case this is defined as household size times the food poverty line). Let l_{it} be a measure of household's *i* livelihood at time *t*, expressed as the ratio of its real income to its subsistence needs:

$$l_{it} = \frac{y_{it}}{S_{it}} = \frac{y_{it}}{householdsize_{it} * foodpovertyline_t}$$

Hence l_{it} measures a household's well-being in poverty line units (PLU's). This variable equals one when the average income of the household members is exactly equal to the food poverty line and $l_{it} < 1$ and $l_{it} > 1$ indicate if household *i* is poor or non-poor at time *t*.

The following regression function relates livelihood of household *i* at time *t* to the bundle of assets owned by that household and its characteristics:

$$l_{it} = \alpha_0 + \sum_{k=1}^{K} \alpha_k a_{itk} + \sum_{t=2}^{T} \delta_t T_t + U_i + \varepsilon_{it} \tag{2}$$

$$\varepsilon_{it} \sim N\left(0, \sigma_\varepsilon^2\right)$$
$$1 \leq i \leq N$$
$$1 \leq t \leq T$$

The fitted values of this regression, A_{it}, can be interpreted as an asset-based index of household well-being in which assets and household characteristics $(a_1, a_2, ..., a_K)$ are weighted according to their marginal contribution to well-being:

$$A_{it} = \hat{\alpha}_0 + \sum_{k=1}^{K} \hat{\alpha}_k a_{itk} + \sum_{t=2}^{T} \hat{\delta}_t T_t + \hat{U}_i \tag{3}$$

The creation of an asset index eliminates stochastic shocks and retains the asset-based expected level of livelihood. This allows distinguishing structurally-poor households ($y_{it} < \bar{y}_t$, $l_{it} < 1$ and $A_{it} < 1$) from stochastically-poor households ($y_{it} < \bar{y}_t$, $l_{it} < 1$, and $A_{it} \geq 1$).

1.3.2. Decomposing poverty transitions

Regarding poverty transitions, third generation poverty analysis examines the degree to which those observed to move out of poverty were simply stochastically-poor or unlucky during the previous periods, or whether they were successful in accumulating and structurally moving out of poverty. Transitions out of poverty may be divided into three types. The first could be the result of a temporary spell of good luck (stochastic poverty transition). The second could be generated from a recovery from a bad luck episode (stochastic poverty transition). The third could result from a structural change, such as the accumulation of new assets or enhanced returns to assets already possessed (structural poverty transition).

From second generation poverty analysis we are able to categorize households into the always poor, the sometimes poor and the never poor according to their income dynamics. This is done by examining whether their income is above or below the income poverty line in each of the periods. Similarly, once the asset index, A_{it}, has been constructed, we now have enough information to characterize each household's asset poverty dynamics by examining whether they are above or below the asset poverty line, which in this case is $\bar{A}_t = \bar{A}_{t-1} = 1$.

TABLE 1. DECOMPOSITION OF ALL POSSIBLE INCOME AND ASSET POVERTY DYNAMICS

	$y_{it} < \bar{y}_t$	$y_{it} \geq \bar{y}_t$
$y_{it-1} < \bar{y}_{t-1}$	1. ALWAYS POOR	3. GOT AHEAD
$y_{it-1} \geq \bar{y}_{t-1}$	2. FELL BEHIND	4. NEVER POOR

Income poverty transition matrix

	$A_{it} < 1$	$A_{it} \geq 1$
$A_{it-1} < 1$	A. ALWAYS BELOW ASSET POVERTY LINE	C. ASSET ACCUMULATION
$A_{it-1} \geq 1$	B. ASSET LOSS	D. ALWAYS ABOVE ASSET POVERTY LINE

Asset poverty transition matrix

Similar to an income poverty transition matrix, there are also four possible scenarios in an asset poverty transition matrix as shown in Table 1. The interpretation of the multiple combinations of income and asset poverty dynamics shown in the table is as follows. Considering two periods (t-1 and t), the three types of transitions out of poverty described previously can be identified by analyzing four possible cases. Cases 3a and 3b both represent temporary spells of good luck (stochastic poverty transitions) in which a household's income above the poverty line in period t ($y_{it} \geq \bar{y}_t$) is not supported by an asset index above the asset poverty line ($A_{it} < 1$). Then, these households are stochastically non-poor in period t and are not expected to maintain their non-poor status over time (further positive stochastic shocks being absent). For the second type of upward poverty transition, Case 3d, households may have been initially poor because of a negative shock ($y_{it-1} < \overline{y}_{t-1}$ although $A_{it-1} \geq 1$). Their assets in t-1 were expected to yield a livelihood above the poverty line, but they may have been pushed below the poverty line by a bad luck episode. Then, in Case 3d the transition to the non-poor state reflects a return to an expected non-poor standard of living (stochastic poverty transition). Finally, Case 3c ($y_{it-1} < \overline{y}_{t-1}, A_{it-1} < 1, y_{it} \geq \overline{y}_t$, and $A_{it} \geq 1$) represents the structural transition to a non-poor state due to the accumulation of new assets or enhanced returns to existing ones.

Following a similar logic, it is possible to identify stochastic from structural poverty transitions among those falling into poverty. The first type of stochastic poverty transition, Cases 2c and 2d, is the result of a temporary spell of bad luck in period t ($y_{it} < \overline{y}_t$ although $A_{it} \geq 1$) for a household that was not poor in period t-1. The second type of stochastic poverty transition, Case 2a, is the result of falling back into poverty after a good luck episode ($y_{it-1} \geq \overline{y}_{t-1}$ although $A_{it-1} < 1$, now $y_{it} < \overline{y}_t$ and $A_{it} < 1$). The third type, the structural poverty transition in Case 2b, results from the loss of assets or the deterioration of the returns to assets possessed.

Among households identified as always poor (income below poverty line during both periods), it is possible to identify Case 1a, the structurally-poor households that were structurally poor in period t-1 and over time failed to accumulate the assets and entitlements related to obtaining a level of income above the poverty line in period t. The rest of the always poor, Cases 1b, 1c, and 1d, are households who have experienced entitlement failures (negative stochastic shocks). This means that having an asset base that would be expected to yield a livelihood above the poverty line, these households were pushed below the poverty line by negative livelihood shocks in the initial period (Case 1b), the final period (Case 1c) or in both periods (Case 1d).

Finally, among the never poor, it is also possible to distinguish the structurally never poor in Case 4d, a group of households that possess an asset base that supports their non-poor level of income in both periods. The rest are households that have experienced positive shocks in either the initial period (Case 4c), the final period (Case 4b) or in both periods (Case 4a).

1.4. The fourth generation

As pointed out by Adato *et al.* (2006), identifying the currently structurally poor from third generation poverty analysis does not tell us whether they are on a trajectory of asset accumulation that will allow them to eventually exit poverty in the long term or whether they are caught in a poverty trap. Then, a fourth generation approach to poverty measurement is needed to examine the possible existence of poverty traps based on an understanding of underlying patterns of asset dynamics and to determine if certain households are expected to remain persistently poor over the long term.

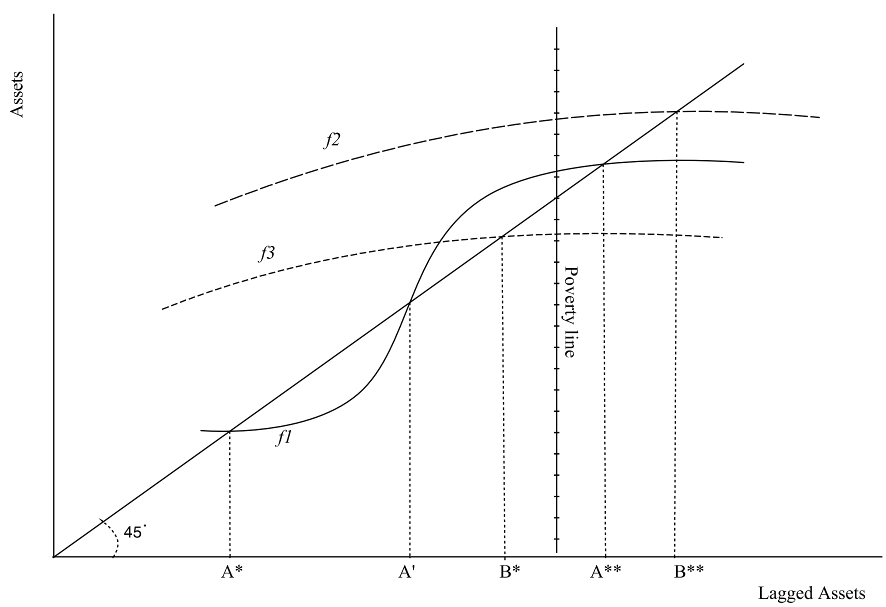
Azariadis (2004) defines a poverty trap as any self-reinforcing mechanism that causes poverty to persist, which may occur at any scale from individuals to families, communities, regions, and countries. There are many mechanisms that potentially produce poverty traps. These mechanisms include scale economies in production, incomplete financial markets, economic and political institutions that privilege the elite, and social norms.

Azariadis identifies three broad explanations for the persistence of poverty. First, there may be critical thresholds that must be reached for the individual to be able to escape poverty. These thresholds may arise when lumpy investments are required to increase productivity, or more generally when there are scale economies (Bowles *et al.*, 2006). For example, if unskilled wage rates are depressed by an oversupply of uneducated persons, a poor person may never be able to save enough to escape poverty if he remains in a developing country with a large uneducated population, but may escape poverty if he moves to a country with a larger educated population. Second, dysfunctional institutions may entrap entire nations in poverty. High inequality in power and wealth influences the support for public schools, public goods, and the protection of property rights. A society that does not have well-established property rights will be characterized by low investment, and a society with low quality public education will likely contain groups of persistently poor citizens. Third, the interaction of slightly distorted behaviors of individuals within a group (i.e., neighborhood effects) may produce very large distortions that may lead to low-level equilibrium traps. For example, low levels of educational attainment among subgroups in the population can become an equilibrium if each individual's well-being is influenced by his conformity with the attainments of his peer group.

In this work we aim to test for the existence of poverty traps that arise due to the existence of critical thresholds. To do so we follow the work of Carter and Barrett (2006). The poverty trap mechanism for agrarian communities that they propose is characterized by the existence of high-return productive activities that are available only to households that can afford to invest in them. For example, there may be higher-return crops and agronomic practices only available to households who reach a critical scale of operation. Relatively wealthy households may afford the sunk costs necessary to undertake a productive investment while poor households may not.

According to their model, households that adopt a higher-return productive activity reach a higher steady-state value of well-being. Households that maintain the lower-return productive activity are caught in a lower level of welfare and will only be able to escape from it if they can afford to switch to the higher-earning strategy. Therefore, the key question is whether households with the lower-return productive activity will be able to move closer to the level of wealth where increasing returns occur and afford to switch to the higher-return productive activity. This minimum level of wealth at which households find it feasible to make the necessary sacrifices to save and switch to the higher-return productive activity is called the Micawber threshold. Finding a Micawber threshold, based on observed behavior, can separate households lacking the assets and entitlements needed to escape poverty over time from those engaged in a cycle of asset accumulation that may lead to better standards of living in the future.

FIGURE 1: ASSET RECURSION DIAGRAM THAT ILLUSTRATES MULTIPLE DYNAMIC EQUILIBRIA DYNAMICS AND CONDITIONAL CONVERGENCE DYNAMICS



Function *f1* in Figure 1 shows the basic logic of Carter and Barrett's (2006) model. It illustrates the S-shaped dynamics of a model with two stable equilibria (A* and A**) and a Micawber threshold (A'), an unstable equilibrium where the asset accumulation bifurcates. For a model with these characteristics, the value A* denotes the steady state equilibrium yielding a low level of income to all households restricted to the lower-return productive activity. The equilibrium A** denotes the same thing for the higher-return productive activity, yielding a higher steady state level of income. According to this figure, because A* is located below the poverty line and A** is located above, any individual who settles into equilibrium at A* would be caught in a poverty trap even though in principle a higher non-poor equilibrium exists.

Households whose assets place them above the Micawber threshold (A') would be expected to escape poverty over time, while those below would not. One needs to identify this dynamic asset poverty threshold in order to disaggregate the structurally poor into those expected to escape poverty on their own over time through predictable asset accumulation and those expected to be trapped in poverty indefinitely (Carter and Barrett, 2006). The empirical challenge is to find whether such a threshold exists and, if so, where.

Extending the logic of Carter and Barrett's framework one can also illustrate the possibility of a single equilibrium. For example, function *f2* illustrates the case in which there is no poverty trap and households unconditionally converge to an equilibrium B** above the poverty line. In contrast, households whose asset dynamics behave as function *f3* would be expected to reach B*, a single steady-state stable equilibrium located below the poverty line. The idea of conditional or club convergence refers to groups of individuals who share similar intrinsic characteristics that tend to follow an equilibrium path and converge to a living standard that is unique to their group or club. The intrinsic characteristics model supposes there may exist certain observable or unobservable characteristics trapping members of one club at the low-level equilibrium B*. Meanwhile, the rest of the households may have possibilities to reach the higher-level equilibrium B** and lift themselves out of poverty.

The intrinsic characteristics model suggests households that share a particular location, education level, ethnicity, or social class, may be condemned to reach an equilibrium located below the poverty line. One could argue that there may exist certain barriers related to the characteristics of that subgroup that are consistently limiting their economic opportunities and their capacity to overcome poverty. In the empirical section of this work, we define such subgroups according to their landowning class, their geographical location, the gender of the household head and their education level, arguing that different asset accumulation functions may characterize each subgroup, which would lead them to different equilibria.

1.4.1. Empirics of poverty traps

The literature in development microeconomics offers theories and empirical tests on the existence of poverty traps. The core hypothesis is that multiple dynamic equilibria might exist and thus that initial conditions matter to subsequent income or wealth accumulation trajectories (Lybbert *et al.*, 2004). Under this hypothesis, some subpopulations may enjoy a higher, stable equilibrium while others find themselves trapped at a lower, stable equilibrium. Without a sizable positive shock to their asset holdings or incomes that pushes them across a possible critical threshold, such trapped households' equilibrium welfare does not grow but merely fluctuates around a penurious level. However, if a shock is significant enough to push them across this threshold, households may in fact converge to the higher stable equilibrium.

The wide array of feasible livelihood strategies of a population makes it difficult to proxy household wealth through the aggregation of relevant assets. Lybbert *et al.* (2004) explore these difficulties using a unique, 17-year panel data set collected among Ethiopian pastoralists, one of the world's poorest populations, which depends almost entirely on a single asset for its income and sustenance. The amount of livestock owned by a family comprises the overwhelming share of their limited wealth and serves as a source of food (milk, meat and blood), a provider of services (manure, traction and transport), an object of status, and a store of wealth. For these pastoralists, it is then unnecessary to aggregate additional assets in order to proxy household wealth. By focusing only on livestock dynamics, Lybbert *et al.* (2004) have been able to study the welfare dynamics of this population. This approach has allowed them to identify some non-convexities in the accumulation of cattle leading to an S-shaped asset accumulation curve with two stable equilibria: a low one corresponding to a herd size of one head, and a higher one at a herd size of 40-75 head. They identify 15 head as the threshold level from which households could rationally change their method of raising cattle and adopt a more productive one.

Lybbert *et al.* (2004) have used parametric, non-parametric and semi-parametric regression techniques to estimate the levels of well-being that households are expected to reach over time. Considering parametric regression techniques, a high degree polynomial can be employed. For semi-parametric and non-parametric regression, the relationship between the asset index and its lagged value is unknown and must be estimated by fitting a function through a scatterplot without any assumptions on its functional form.

A simple univariate non-parametric regression is equivalent to fitting a smooth function through a scatterplot without any assumptions as to the functional form. Its two key assumptions are that the function to be estimated is "smooth" and that the covariates are uncorrelated with the error, which is normally and identically distributed with an expected value of zero:

$$
\begin{aligned}
A_{it} &= f\left(A_{it-1}\right) + \varepsilon_{it} \\
\varepsilon_{it} &\sim N\left(0, \sigma_{\varepsilon}^{2}\right) \\
1 &\leq i \leq N \\
1 &\leq t \leq T
\end{aligned}
\qquad (4)
$$

Semi-parametric methods contain a combination of non-parametric and parametric components. A simple semi-parametric model combines an unknown functional form for some variables with a linear model:

$$
\begin{aligned}
A_{it} &= x_{it-1}\beta + f\left(A_{it-1}\right) + \varepsilon_{it} \\
\varepsilon_{it} &\sim N\left(0, \sigma_{\varepsilon}^{2}\right)
\end{aligned}
\qquad (5)
$$

By using a non-parametric and a parametric fit, Barrett *et al.* (2006) find an S-shape in the livestock accumulation dynamics of pastoralists in Kenya. They have also been able to identify two different stable equilibria and an unstable equilibrium. Their hypothesis is that there are places where market failures can lead to sharp differences in productivity among reasonably similar households and, thus, to poverty traps. A market failure may occur especially in the financing necessary to undertake investment or to cope with shocks without liquidating productive assets. In the same study, Barrett *et al.* (2006) do not find evidence of similar patterns in the more favored area of Madagascar's central highlands.

Unlike these studies based on the analysis of livestock dynamics, Naschold (2005) and Adato *et al.* (2006) study households whose strategies rely on more diversified activities. Naschold (2005) uses two data sets from Ethiopia and Pakistan to explore whether the identification of household asset dynamics is affected by choosing parametric versus non-parametric techniques. His results show a unique equilibrium for all of the econometric estimations. Adato *et al.* (2006) implement an analysis of structural dynamics in post-apartheid South Africa and conclude a low-level structural poverty trap could be found over the 1993-98 period. They integrate four different key assets (human, natural and productive capital, and transfer income) into a weighted asset index in order to estimate the asset accumulation path and the poverty dynamics among these households. Having identified an S-shape in the asset accumulation dynamics, they locate a Micawber threshold equal to twice the poverty line. They conclude households below this threshold would be caught in a poverty trap, which would in the long run lead their incomes to an equilibrium 10% lower than the poverty line.

2. Data and results

The data for this study is taken from the first two rounds of the Mexican National Rural Household Survey (ENHRUM), which is a collaborative project between the Colegio de México and the Rural Economies of the Americas and Pacific Rim (REAP) program of the University of California at Davis. The purpose of this survey is to collect economic and social information on rural communities in Mexico to study the rural sector. The first round of the survey was taken in early 2003 (the data is for the year 2002) and the second in early 2008 (the data is for 2007).

The sampling strategy was designed by the Mexican National Institute of Statistics and Geography (INEGI by its initials in Spanish) to be representative of Mexican rural communities with population size between 500 and 2499 (this represents more than 80% of Mexico's rural population). The country was divided into five regions[2] and 16 villages where selected from each region. The sample consists of more than 1700 randomly selected households located in eighty villages from 14 Mexican states. In this study we use a panel consisting of 1529 households.

An important first step in our study was to approximate household income. Detailed data on household-farm production, wage work, and migration make it possible to estimate total income for each household in the ENHRUM sample. Total income results from adding income from six different sources: family production (crop, livestock, non-agricultural, commerce, services, and natural resource extraction), agricultural wage labor, non-agricultural wage labor, internal migrant remittances, international migrant remittances, and public transfers.

Once we approximated household income from this data, first generation poverty measures could be estimated. For this purpose, we use the rural food poverty lines provided by CONEVAL (2009).[3] Table 2 shows the results from measuring the three main variants of the FGT index: the poverty incidence (P_0), the poverty gap (P_1), and the squared poverty gap (P_2). In 2002, almost 40% of Mexican rural households were below the poverty line. Poverty

[2] South-Southeast (Oaxaca, Veracruz and Yucatán), Center (Estado de México and Puebla), Center-West (Guanajuato, Nayarit and Zacatecas), Northwest (Baja California, Sonora and Sinaloa), and Northeast (Chihuahua, Durango and Tamaulipas).

[3] In Mexico, the National Council for the Evaluation of Social Development Policy (CONEVAL) is in charge of establishing the guidelines to determine the poverty line that relates to each of the following definitions of poverty: food poverty (incapability to acquire a basic food basket), capabilities poverty (insufficiency of the available income to acquire the food basket value and make the necessary expenses in health and education), and patrimonial poverty (insufficiency of the available income to acquire the food basket, as well as to make the necessary expenses in health, education, clothing, housing and transportation). For this study, the annual poverty lines were created by multiplying the monthly rural poverty lines provided by CONEVAL times twelve months and adjusting the 2007 poverty lines to 2002 constant Mexican pesos. The resulting food poverty lines are $5,937.36 for 2002 and $6,089.52 for 2007. The exchange rate during the period was approximately 11 pesos per dollar.

incidence decreased to 36% in 2007. The region with the highest percentage of poor is the South-Southeast (65% in 2002 and 50% in 2007). The incidence of poverty decreases in the South-Southeast, Center-West and Northeast regions while it increases for the Center and Northwest regions. The same pattern prevails when we look at the other two measures of poverty.

TABLE 2. FOSTER-GREER-THORBECKE POVERTY MEASURES (NATIONAL AND BY REGION)

	HEADCOUNT (P_0)		POVERTY GAP (P_1)		SQUARED POVERTY GAP (P_2)	
	2002	2007	2002	2007	2002	2007
MEXICO	39.3	35.6	22.7	19.9	19.6	16.8
SOUTH-SOUTHEAST	64.5	50.3	35.9	25.6	25.1	20.8
CENTER	39.3	41.1	19.2	23.4	19.4	21.0
CENTER-WEST	32.1	29.8	19.4	15.3	19.5	11.2
NORTHWEST	21.5	25.8	13.2	16.2	11.9	13.4
NORTHEAST	36.5	27.7	25.3	17.7	21.5	16.9

As was mentioned before, one of the main drawbacks of these first generation poverty measures is that we cannot say anything about changes in the poverty status of households over time. To overcome this we use a poverty transition matrix (a second generation measurement). Table 3 shows that 19% of the surveyed households were poor in both 2002 and 2007. In contrast, 44% of the households had an income above the food poverty line in both periods. This implies that 37% of the households experienced transitory poverty (20% got ahead from poor to non-poor and 17% fell into poverty in 2007 having been non-poor in 2002). An alternative way of interpreting these results is that more than half of the households classified as poor in 2002 were above the poverty line in 2007, while 28% of households classified as non-poor in 2002 fell into poverty in 2007. In any case, the data shows that rural mobility into and out of poverty was relatively common in Mexico in this period.

The poverty mobility indicators in Table 3 provide valuable information. They allow us to conclude that 56% or almost three fifths of the surveyed households experienced poverty at least in one of these periods and that almost one fifth experienced poverty in both periods. However, they do not give us the possibility to empirically distinguish between households that can be expected to escape poverty over time from those that cannot. As a first step towards solving this we apply the third generation poverty measurement approach described in section 1.3.

TABLE 3. POVERTY TRANSITION MATRIX

		2007	
		POOR 36%	NON-POOR 64%
2002	POOR 39%	ALWAYS POOR: 19%	GOT OUT OF POVERTY: 20%
	NON-POOR 61%	FELL INTO POVERTY: 17%	NEVER POOR: 44%

As discussed previously, a key step in third generation poverty analysis is the construction of an asset-based expectation of household welfare. Following the livelihood-weighted asset index methodology, assets considered to play an important role in rural livelihood strategies were identified from the data available from the ENHRUM. In contrast with communities in which livelihood strategies depend on a single relevant asset, for example, cattle for Ethiopian pastoralists (Lybbert *et al.*, 2004), Mexican rural communities engage in very diverse husbandry, agricultural, and commercial activities. While some Mexican households may rely primarily on one type of activity, most seek to diversify their livelihood base as a way to reduce risk. For example, a Mexican rural household may grow corn and beans, for which the extension of land or the machinery it owns may be the main relevant assets. This same household may also breed cows or chicken, or engage in other commercial activities, such as producing and selling handicrafts. At the same time, a part of their income may rely on remittances sent by their family members working in the United States.

Then, a first step in the construction of the asset index was to choose which assets to include in the asset index. The assets and characteristics that were chosen in the estimation of Equation (2) are described in Table 4. A second step involved the transformation of income flows into poverty line units (PLU's), which was conducted by dividing per capita income by the food poverty lines (5,937.36 for 2002 and $6,089.52 for 2007). The resulting household livelihood, l_{it}, has a mean value of 2.50 food PLU's in 2002 and 3.06 food PLU's in 2007. This means on average the surveyed households have a level of income around 2-3 times the food poverty line.

TABLE 4. ASSETS INCLUDED IN THE ASSET INDEX AND MEAN VALUES BY PERIOD

TYPE OF CAPITAL	SUBCATEGORY	ENHRUM	2002	2007
HOUSEHOLD CHARACTERISTICS	HOUSEHOLD HEAD	AGE OF HOUSEHOLD HEAD	48.97	53.69
		SQUARED AGE OF HOUSEHOLD HEAD	2,638	3,120
		GENDER OF HOUSEHOLD HEAD	87%	86%
		EDUCATION OF HOUSEHOLD HEAD	4.50	4.49
PHYSICAL CAPITAL	HOUSING	NUMBER OF ROOMS	2.92	3.08
		KITCHEN	94%	87%
		WALL MATERIAL:		
		PERISHABLE MATERIALS	3%	2%
		WOOD OR METAL	14%	11%
		BLOCK OR ADOBE	24%	24%
		BRICK OR STONE	59%	64%
		ROOF MATERIAL:		
		BRICK	0%	0%
		CARDBOARD	1%	1%
		TILE	5%	5%
		METAL	38%	34%
		PERISHABLE MATERIALS	7%	4%
		WOOD	10%	11%
		CONCRETE	38%	44%
		WINDOWS:		
		NO WINDOWS	8%	8%
		NO GLASS	28%	20%
		GLASS	65%	73%
		BATHROOM:		
		NO BATHROOM	10%	5%
		LATRINE	43%	36%
		TOILET	47%	60%
		WATER SUPPLY	82%	84%
		DRAINAGE	25%	32%
		ELECTRICITY	94%	98%
		TELEPHONE	23%	36%
		REFRIGERATOR	59%	74%
		COOKING FUEL:		
		OTHER FUEL	0%	0%
		BOTH FIREWOOD AND GAS	29%	26%
		FIREWOOD	29%	36%
		GAS	41%	39%
	LAND	LAND	5.14	5.29
		$(\text{LAND})^2$	745	760
	LIVESTOCK	COWS	1.39	1.48
		CALVES	0.58	0.71
		BULLS AND OXEN	0.12	0.14
		HORSES	0.21	0.27
		DONKEYS	0.14	0.13
FINANCIAL/ PRODUCTIVE CAPITAL	PRODUCTIVE DURABLES	AUTOMOBILE	0.15	0.19
		TRUCK	0.18	0.25
		TRACTOR	0.04	0.05
		CULTIVATOR	0.01	0.03
		MILL	0.01	0.04
	TRANSFER INCOME	NUMBER OF HOUSEHOLD MEMBERS	0.29	0.59

TYPE OF CAPITAL	SUBCATEGORY	ENHRUM	2002	2007
		IN THE US		
		TRANSFERS	666.95	682.58
		$(\text{TRANSFERS})^2$		
		(TRANSFERS)(LAND)	7,405	6,288
HUMAN CAPITAL	LANGUAGES	SPANISH	82%	80%
		ENGLISH	1%	4%
	HEALTH	BAD	40%	35%
		AVERAGE	9%	14%
		GOOD	51%	51%

The final step in the construction of the asset index was to estimate Equation (2) using fixed and random effects models. The random effects model is preferred because a Hausman test against the fixed effects model did not reject the null hypothesis that the coefficients are the same. The probability that the critical x^2 value with 43 degrees of freedom is greater than the observed x^2 of 52.35 is equal to one. The resulting random effects asset index takes values from -1.81 to 29.63 food PLU's and has a mean value of 2.78 food PLU's.[4]

TABLE 5. POVERTY TRANSITION MATRIX AND THIRD GENERATION POVERTY MEASURES

		2007: POOR 36%	2007: NON-POOR 64%
2002	POOR 39%	19% ALWAYS POOR, OF WHICH: *23% STRUCTURALLY POOR IN BOTH PERIODS* *77% NEGATIVE STOCHASTIC SHOCKS*	20% GOT AHEAD, OF WHICH: *14% STOCHASTICALLY-NON-POOR IN 2007* *73% NON-POOR WHO WERE UNFORTUNATE IN THE INITIAL PERIOD* *13% NEW STRUCTURALLY-NON-POOR, ACCUMULATED ASSETS TO BECOME STRUCTURALLY NON-POOR IN 2007.*
2002	NON-POOR 61%	17% FELL BEHIND, OF WHICH: *88% STOCHASTICALLY-POOR IN 2007* *7% POOR WHO WERE FORTUNATE IN THE INITIAL PERIOD* *5 % NEW STRUCTURALLY-POOR, LOST THEIR INITIALLY NON-POOR ASSET BASE AND BECAME STRUCTURALLY POOR IN 2007*	44% NEVER POOR, OF WHICH: *84% STRUCTURALLY NON-POOR IN BOTH PERIODS* *16% POSITIVE STOCHASTIC SHOCKS*

The generation of an asset-based expectation of household welfare allows disaggregating households according to their structural or stochastic poverty

[4] As a robustness check we constructed an asset index using the first principal component from a polychoric PCA as suggested by Kolenikov and Angeles (2004). The results were very similar to those presented here. The correlation between the polychoric PCA index and the livelihood-weighted random effects index is .705. Besides, the pattern of asset dynamics does not vary substantively across these two alternate methods of construction of an asset index.

status by verifying if a household's asset index behaves in the same manner in relation to the asset poverty line as the household's income in relation to the income poverty line. The results, shown in Table 5, indicate that among households identified as always poor (income below poverty line during both periods), 23% are always structurally-poor households. These households were structurally poor in 2002 and over time failed to accumulate assets and entitlements related to obtaining a level of income above the poverty line in 2007. Most importantly, these always structurally-poor households, which represent 4.38% of the total sample, are the most likely to remain poor in the future. The remaining 77% of the always poor have been poor, but not structurally-poor, in both periods which means they have experienced entitlement failures.

Among households who were poor in 2002 and moved ahead in 2007, 14% of households received positive stochastic shocks that have pushed them above the poverty line in 2007, but lack the necessary asset base to be expected to maintain their non-poor status over time. Then, these transitions to a non-poor state are the result of a good luck episode and these households are not expected to escape poverty permanently. Secondly, 73% were unlucky in 2002 but returned to their expected non-poor level of income in 2007. This means most of the upward transitions were stochastic, which implies that they are not the result of asset accumulation but a return to their expected non-poor level of income. Only 13% of households in this category did accumulate assets that allowed them to reach a structurally-non-poor status in 2007. This provides a good example of the use of third generation poverty analysis. At first we knew 20% of households had got out of poverty from 2002 to 2007, but now we know only 13% of these households (2.75% of the total sample) successfully accumulated assets to reach a non-poor state over this period.

Among households who were non-poor in 2002 and fell behind in 2007, it is also possible to distinguish structural from poverty transitions. From the households in this category, 88% received negative stochastic shocks that made them poor although they were expected to be non-poor in 2007. Secondly, 7% were initially lucky, but fell back to their expected level of income below the poverty line in 2007. Thirdly, 5% of these households lost their asset base and experienced a structural transition into poverty in 2007. This suggests 2007 may have been a year in which negative stochastic shocks to households that were expected to be non-poor were the main cause of downward mobility.

Finally, among the never poor, it is possible to distinguish a group of households that have accumulated an asset base that supports their structurally non-poor level of income in both periods (84%). These always structurally non-poor households (37% of the total sample) are the least likely to fall back into poverty. In contrast, 16% of the never poor are households that have experienced positive shocks in either one of the periods or in both periods.

Overall, it is possible to conclude that, although 36% of households were considered poor in 2007, only 7% were structurally poor, and from 64% of households who were considered non-poor in 2007, 58.6% were structurally non-poor. This last result is probably the most useful because if in the latest period 58.6% of households were structurally non-poor, the rest of them (41.4% of the surveyed households) are vulnerable either because they are structurally-poor (7%), because their non-poor status is due to positive shocks and probably not going to be sustained (5.8%) or because they face constraints that limit household's ability to effectively utilize their assets and endowments (28.6%). This suggests the constraints that limit the effectiveness with which productive assets are used are an important cause of vulnerability. Households may own land, a house, livestock and machinery, but they may face difficulties in generating profits from their productive activities.

The third generation poverty measures provide valuable information about how much poverty is likely to persist in the short-term. For the previous analysis, 7% of the sample was structurally poor in 2007, which means they had low income and few assets. However, this does not say anything about the long-term dynamics of asset accumulation and therefore about the potential existence of poverty traps. It may be that the structurally poor are slowly accumulating assets and will eventually reach the asset poverty line. In contrast, it may also be that they are losing over time the few assets that they possess. Therefore, the final step of our analysis is to use fourth generation poverty measures to look at the long-term trend of poverty in rural Mexico.

The first econometric technique used is the parametric polynomial model. In this model, the control variables (x_{it-1}) are introduced in a linear form (except the age of the household head since its squared value is also included) while the asset index for the initial year is included as a fourth degree polynomial. The control variables used in the econometric analysis are described in Table 6.

TABLE 6. CONTROL VARIABLES AND MEAN VALUES BY PERIOD

VARIABLE NAME	RANGE	2002	2007
AGE OF HOUSEHOLD HEAD	16-99 YEARS	48.97	53.69
SQUARED AGE OF HOUSEHOLD HEAD		2,638	3,120
GENDER OF HOUSEHOLD HEAD	MALE 1 FEMALE 0	87%	86%
HOUSEHOLD SIZE	1-14 MEMBERS	4.16	4.80
NO. MEMBERS COMPLETED PRIMARY	0-9 MEMBERS	2.72	4.28
NO. MEMBERS COMPLETED SECONDARY	0-7 MEMBERS	1.22	2.29
EDUCATION OF HOUSEHOLD HEAD	0-20 YEARS	4.50	4.49

The parametric analysis is complemented with two semi-parametric techniques, penalized splines and kernel-weighted regressions. Adapting the notation from Ruppert *et al.* (2003) and Naschold (2005), in a spline model the non-parametric function takes the following form:

$$f\left(A_{it-1}\right)=\beta_0+\beta_A A_{it-1}+\sum_{s=1}^{S}u_s\left(A_{it-1}-k_s\right)_+$$

$$u=\begin{pmatrix}u_1\\u_2\\\vdots\\u_s\end{pmatrix}\sim N\left(0,\sigma_u^2\right) \tag{6}$$

k represents a knot and there are S number of knots (Ruppert *et al.*, 2003; Naschold, 2005). The penalized splines model can be explained by a mixed model methodology where there is a smoothing parameter that controls the amount of smoothing and penalizes the number of knots. This smoothing parameter is estimated through a restricted maximum likelihood (REML) and the penalized splines are estimated as best linear unbiased predictors (BLUPs) from the mixed model (Ruppert *et al.*, 2003).

On the other hand, Kernel-weighted regression finds the best-fit regression function to match the data. The idea of kernel regression is putting a set of identical weighted functions called kernel at each observational data point. The kernel will assign weight to each location based on distance from the data point.[5] The parameters of interest in this case are β and the issue is how to estimate them in the presence of an unknown function $f\left(A_{it-1}\right)$ such as the

[5] For a full description of the method, see Pagan and Ullah (1999).

model in equation (5). Taking the conditional expectation of the model in equation (5) leads to:

$$E\left(A_{it} / A_{it-1}\right)=E\left(x_{it-1} / A_{it-1}\right)\beta+f\left(A_{it-1}\right) \quad (7)$$

Consequently, substracting (7) from (5):

$$A_{it}-E\left(A_{it} / A_{it-1}\right)=\left(x_{it-1}-E\left(x_{it-1} / A_{it-1}\right)\right)\beta+\varepsilon_{it} \quad (8)$$

and from (7):

$$f\left(A_{it-1}\right)=E\left(A_{it} / A_{it-1}\right)-E\left(x_{it-1} / A_{it-1}\right)\beta \quad (9)$$

Since this transformation to equation (8) has the properties of a linear regression model with dependent variable $A_{it}-E\left(A_{it} / A_{it-1}\right)$ and independent variables $x_{it-1}-E\left(x_{it-1} / A_{it-1}\right)$ an obvious estimator of β is:

$$\begin{aligned}\hat{\beta}=&\left(\sum_{t=1}^{T}\sum_{i=1}^{N}\left(x_{it-1}-E\left(x_{it-1} / A_{it-1}\right)\right)'\left(x_{it-1}-E\left(x_{it-1} / A_{it-1}\right)\right)\right)^{-1} * \\ &*\left(\sum_{t=1}^{T}\sum_{i=1}^{N}\left(x_{it-1}-E\left(x_{it-1} / A_{it-1}\right)\right)'\left(A_{it}-E\left(A_{it} / A_{it-1}\right)\right)\right)\end{aligned} \quad (10)$$

$E\left(A_{it} / A_{it-1}\right)$ and $E\left(x_{it-1} / A_{it-1}\right)$ are Kernel-based Nadaraya-Watson estimators. Once $\hat{\beta}$ is found, $\hat{f}\left(A_{it-1}\right)$ can be estimated using:

$$\hat{f}\left(A_{it-1}\right)=E\left(A_{it} / A_{it-1}\right)-E\left(x_{it-1} / A_{it-1}\right)\hat{\beta} \quad (11)$$

Figure 2 shows the results of the econometric estimation aimed towards testing for the existence of a poverty trap.[6] The asset index is scattered fairly closely to the 45-degree line, which suggests a low level of asset mobility. There is a very slight difference among the three estimation techniques. Most importantly, the three techniques show similar evidence of non-linear dynamics towards the tails of the distribution, but an almost linear behavior in the middle. Besides, the non-linear dynamics at the tails of the distribution

[6] The only control variables that had a significant effect on the behavior of the index in 2007 were the age, the squared age, and the gender of the household head. The Kernel-weighted estimation uses Epanechnikov kernel with a bandwidth of 0.8702. The polynomial's estimated coefficients are significant, and the joint hypothesis of these estimators to be zero is rejected, which is a signal that the asset dynamics are not linear.

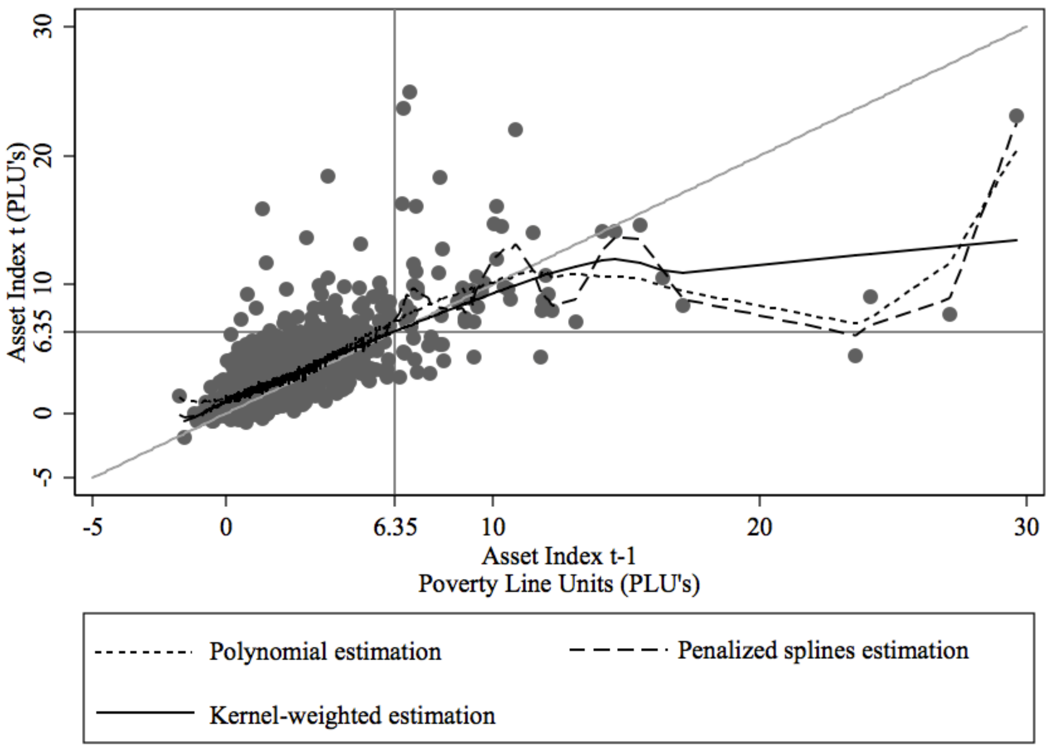
are not sufficient to suggest the existence of multiple equilibria. The results do not support the hypothesis that multiple equilibria may characterize the behavior of the asset index dynamics. The estimation results are shown in Table 7.

TABLE 7. ESTIMATION RESULTS FOR THE COUNTRY-LEVEL INDEX

VARIABLE	POLYNOMIAL REGRESSION	PENALIZED SPLINES	KERNEL-WEIGHTED REGRESSION
AGE OF HOUSEHOLD HEAD	0.04***	0.06***	0.06***
	(0.008)	(0.018)	(0.022)
SQUARED AGE OF HOUSEHOLD HEAD	-0.00***	-0.00***	-0.00**
	(0)	(0)	(0)
GENDER OF HOUSEHOLD HEAD	0.23*	0.24*	0.30*
	(0.126)	(0.129)	(0.163)
HOUSEHOLD SIZE	-0.01	0	-0.01
	(0.028)	(0.027)	(0.034)
NO. MEMBERS COMPLETED PRIMARY	0.07*	0.05	0.03
	(0.038)	(0.037)	(0.048)
NO. MEMBERS COMPLETED SECONDARY	-0.07	-0.06	-0.05
	(0.045)	(0.045)	(0.055)
EDUCATION OF HOUSEHOLD HEAD	0	0.01	0.02
	(0.014)	(0.014)	(0.018)
$AssetIndex_{t-1}$	0.38***	0.4	
	(0.091)	(2.898)	
$AssetIndex_{t-1}^2$	0.18***		
	(0.02)		
$AssetIndex_{t-1}^3$	-0.02***		
	(0.002)		
$AssetIndex_{t-1}^4$	0.00***		
	(0)		

* p ≤ .1; ** p ≤ .05; *** p ≤ .01

FIGURE 2. POLYNOMIAL, PENALIZED SPLINES AND KERNEL-WEIGHTED ESTIMATION RESULTS



Unlike other studies, no evidence of critical thresholds has been found because asset dynamics show evidence on the existence of a single stable equilibrium shared by the whole surveyed rural population. A possible explanation for this is that the three econometric techniques rely heavily on the existence of outliers in order to predict the existence of non-linear dynamics. Not only are these outliers too few, but these outliers are also below the 45-degree line. Therefore, even if their level of wealth is high, they are still expected to converge back to the same equilibrium as the rest of the observations. The existence of these few outliers is not sufficient to show the existence of an unstable equilibrium, which would be necessary to suggest the existence of a higher-level equilibrium and a poverty trap.

If there is only one equilibrium, the question is, how is this equilibrium level of welfare relative to the poverty line and how fast households move towards it. Figure 2 shows that this equilibrium is located around 6.35 food poverty line units (this means that, in equilibrium, an individual lives with approximately 105 pesos per day). These results imply that, all stochastic shocks being absent, rural Mexican households are expected to reach a common long-term level of asset wealth that is more than 6 times the food poverty line. This equilibrium is also larger than the capabilities poverty line, which is equal to 1.18 food PLU's, and the patrimonial poverty line, equal to

1.81 food PLU's. This implies that the poverty status of the currently structurally poor in rural Mexico is not expected to persist in the long run because they are expected to reach an equilibrium that is higher than any of the three poverty lines.

Besides looking at the whole sample it is interesting to analyze if different subgroups are expected to behave in different ways. For this purpose, the polynomial, penalized splines, and Kernel-weighted regressions were applied to subgroups of the surveyed population.[7] The analysis by regions suggests the existence of a single stable equilibrium for each of the regions. However, the location of this equilibrium varies. Although all regions are expected to overcome poverty over time, there is a very considerable difference in the levels of welfare they are expected to reach. The Center, Center-West and Northwest regions have a very similar equilibrium level around 5-7 food PLU's, which is very similar to the equilibrium found for the whole country. However, the least-developed region, the South-Southeast, converges to a lower-level equilibrium of 3.68 food PLU's (61 pesos per day for an individual) and the Northeast region converges to a higher-level equilibrium of 12 food PLU's (200 pesos per day for an individual).

Additional conditional convergence patterns are shown in Table 8. Households headed by a male are expected to reach a higher equilibrium than households headed by a female. Meanwhile, an equilibrium level close to 10 PLU's was found for those households whose household head had completed primary school. In comparison, households whose head had not completed at least 6 years of education are expected to reach an equilibrium at 6.88 PLU's. The analysis by amount of land owned shows that households that do not own any land, who represent almost half of the surveyed households, reach a low-level equilibrium around 3.90 PLU's. In contrast, small landholders (less than or equal to 5 ha.), who represent 30% of surveyed households, reach an equilibrium at 6.60 PLU's and households that own a greater amount of land (more than 5 ha.), who represent the remaining 20% of surveyed households, reach an equilibrium around 7.42 PLU's. Land is clearly a very valuable asset in rural Mexico.

[7] The three econometric techniques give very similar results.

TABLE 8. STABLE DYNAMIC ASSET EQUILIBRIA BY SUBGROUPS

	NUMBER OF OBSERVATIONS	APPROXIMATE LOCATION OF STABLE EQUILIBRIUM IN FOOD POVERTY LINE UNITS	APPROXIMATE LOCATION OF STABLE EQUILIBRIUM IN PESOS PER CAPITA PER DAY
ALL	1529	6.35	105.94
BY REGION			
SOUTH-SOUTHEAST	332	3.68	61.40
NORTHWEST	298	5.06	84.42
CENTER-WEST	312	5.21	86.92
CENTER	338	7.26	121.12
NORTHEAST	249	12	200.20
BY HOUSEHOLD HEAD GENDER			
FEMALE	206	5.39	89.93
MALE	1323	7.41	123.63
BY EDUCATION OF HOUSEHOLD HEAD			
UP TO 5 YEARS	905	6.88	114.78
PRIMARY SCHOOL OR MORE	624	9.96	166.17
BY LAND OWNERSHIP			
NO LAND	746	3.90	65.07
0 < LAND < 5 HA.	465	6.60	110.11
MORE THAN 5 HA.	318	7.42	123.79

Conclusions

The study of poverty has led to the development of four generations of poverty measures. Each of these approaches is followed in this study to analyze rural poverty dynamics in Mexico. The first approach, based on data from a single point in time, indicated 35-40% of the Mexican rural population suffers from food poverty. Although FGT measures suggest a reduction of rural poverty from 2002 to 2007, food poverty is still high in 2007, particularly in the South-Southeast region of Mexico. Then, a second approach to poverty analysis, based on the measurement of poverty over time using the same set of households, indicated almost three fifths of the households experienced poverty at least in one of these periods. Chronic poverty, households that were poor in both 2002 and 2007, comprises almost one fifth of overall poverty, while transitory poverty comprises almost two fifths. This suggests mobility into and out of poverty is relatively common in rural Mexico.

A third approach to poverty analysis is then necessary to distinguish if the reasons why the poor are poor are structural, meaning they lack the assets and entitlements to obtain income, or stochastic, meaning they could have suffered negative shocks from which they are expected to recover over the long term. This study concludes that although 36% of households were considered poor in 2007, only 7% were structurally poor. On the other hand, although 64% of households were non-poor in 2007, only 58.6% were structurally non-poor. This means 41.4% of the surveyed households are vulnerable either because they are structurally-poor, because their non-poor status is due to positive shocks and probably not going to be sustained or because they face constraints that limit household's ability to effectively utilize their assets and endowments. The importance of this last cause of vulnerability suggests further analysis of the constraints that limit the effectiveness with which productive assets can be used to generate income in rural areas.

Finally, the fourth approach analyzed asset-based expected welfare dynamics to test for the existence of poverty traps among Mexican rural households. The disaggregation of this analysis into subgroups resulted in patterns of conditional convergence by location and by some other household characteristics, all of which lead to an equilibrium above the poverty line. An implication of this result is that, in the absence of negative shocks, there is no reason to expect structural poverty to persist over the long-term and therefore all rural households are expected to reach a non-poor state over time. Nevertheless, one should not be overly optimistic about this result because the long-run equilibrium that households are expected to reach is barely above the income needed to buy a basic food basket and to pay for basic health, education, clothing, housing and transportation expenses (i.e., the so called patrimonial poverty line). Therefore, even if in fact this equilibrium is reached and no rural household is below the poverty line they will still be in a very precarious condition with the average rural individual living with 105 pesos per day.

Subgroup convergence patterns show that the situation of households headed by a female, households whose household head has not completed primary school, and households that do not own land would be aggravated by reaching even lower equilibria. The effect of land ownership is particularly important as the equilibrium level that landless households are expected to reach is almost half the level that those with at least 5 hectares are expected to reach.

The analysis of regional level equilibria suggests that welfare disparities between some regions of Mexico are expected to increase. Households located in the South-Southeast region of Mexico are expected to reach a lower level of well-being, and are trapped in relative poverty. Then, it must be that some mechanisms are persistently reducing the productivity of households in the South-Southeast region. Critical thresholds that may inhibit the adoption of new technologies, dysfunctional institutions that protect a narrow elite, and the distortion of households' behavior by neighborhood effects are some examples of such kind of mechanisms. On the other hand, households from the Northeast region are expected to reach a level of well-being that is more than three times the level of the South-Southeast.

One could argue that if in fact these tendencies materialize households will have an even higher incentive to migrate to the Northeast, where the equilibrium they are expected to reach is higher. Taking the logic one step further one could say that given the low-level equilibrium that is expected for rural Mexican households the incentives to migrate to the United States will continue to exist in the long-run. Of course this assumes that the long run equilibrium level in the Unites States is higher, which is something we did not measure but that is very intuitive. One could say that even though Mexican rural households are not in a poverty trap in the absolute sense they are in fact trapped in a low-level equilibrium. It thus seems that for some households the only way to escape that trap is by moving to the United States in expectation of reaching a higher equilibrium.

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