The existence of Poverty Traps: 
Old Question - New Answer. 
Evidence from Rural Mexico 

George Washington University Seminar 

Vera Chiodi* 

*Paris School of Economics & Poverty Action Lab - Europe 

November 13th, 2009
Plan

1. Introduction
2. The Data
3. Evidence of Poverty Traps
4. Conclusion
Motivation

- Poverty associated with informational/market failures that affect the poor more severely
- Poverty traps as a major cause of persistent inequality and a serious limitation to growth
- Panel of poor rural HH in Mexico for the last decade
  - Identify their potential for asset accumulation
- But, poverty traps may hinder this process
Credit constraints prevent the poor from starting up investment projects or accumulating human capital.

The initial wealth distribution plays a determinant role in the development path (Banerjee-Newman, 1993) (Piketty, 1997; Aghion-Bolton, 1997).

Here, partial equilibrium accumulation dynamics: Galor-Zeira (1993) where dynasties accumulate (human capital) independently from one another and may fall into poverty traps.

On the other hand..., Macro-based poverty traps: aggregate non-convexities and aggregate coordination failures.
Bifurcated asset dynamics in South Africa (Adato, Carter, May 2006)
  Qualitative data: social capital & networks

Long term Effects of Short term Shocks (Carter, Little, Mogues 2007)
  Honduras & Ethiopia
  In the wake of environmental shocks
  Adopt costly coping strategies

Asset or consumption smoothing in rural Zimbabwe (Hoddinott, 2006)
  Temporary income shocks & permanent consequences across and within HH
  Impact of shocks by levels of asset holdings and by individual level
Multiple vs. Single Equilibrium Asset Growth Paths

- Threshold below which unable to accumulate assets
- Converge to a low asset/low income equilibrium
- Large positive shocks or an improvement in the returns
Poverty trap arises when:

1. Locally increasing returns over a range of levels of asset

2. Presence of a market failure: high rates of return for Mexican Microenterprises but severe capital constraints (Mckenzie and Woodruff, 2006)

If diminishing marginal returns over all levels → dynamic path as a globally concave curve

- If this growth regime holds → only one equilibrium exists
My contribution

- Empirical test for poverty traps, through several empirical strategies
  - Non-parametric and parametric
  - Calculation of the stable and unstable equilibrium

- Find differences in dynamic paths by exploring heterogeneity across households
  - Divide low-ability poor and high-ability poor
Plan

1. Introduction
2. The Data
3. Evidence of Poverty Traps
4. Conclusion
The data

- New data available from a panel of poor HH in rural Mexico
  - 10% random sample of poor rural localities
  - Representative of the extreme rural poor
  - Panel of 3 time observations, 1996 to 2006
  - Around 4,400 households from 190 rural localities

<table>
<thead>
<tr>
<th>Period</th>
<th>% below the PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>76</td>
</tr>
<tr>
<td>II</td>
<td>78</td>
</tr>
<tr>
<td>III</td>
<td>66</td>
</tr>
</tbody>
</table>
Plan

1. Introduction
2. The Data
3. Evidence of Poverty Traps
4. Conclusion
Marginal Returns: asset index

Asset index – Period I

Vera Chiodi (PSE & J-PAL)
Poverty traps in rural Mexico
November 13th, 2009
Evidence of Poverty Traps

Marginal Returns: labor force

Quantity of male working adults per HH – Period II

Vera Chiodi (PSE & J-PAL)
Evidence of Poverty Traps

Marginal Returns: education

Years of education of the HH head – Period III

Vera Chiodi (PSE & J-PAL)
Poverty traps in rural Mexico
November 13th, 2009
Evidence of Poverty Traps

Empirical investigation of the welfare dynamics

- Uni-dimensional measure requiring:
  1. Either complete knowledge of the market value of each asset,
  2. or the construction of an asset index with two possible strategies:
     - Factor Analysis
     - Regression analysis (monthly per capita income of 47 US$)
Empirical Strategy I: Factor Analysis

- Asset index using factor analysis
  - Maintain initial weights to the following years
- Three categories:
  - HH durables (ownership of radios, TV, refrigerator, gas stove, washing machine and vehicles)
  - Housing quality (irrigation to land, electricity earthfloor, roof weak, animals, owned house, use of agricultural land)
  - Stock of human capital (years of education of the hh head)
Prices often unknown or difficult to determine, methodology used by Adato et al. (2004); McKenzie (2005).

HH income regressed on HH’s assets, its square and cube, along with interactions

HH asset index is the HH income predicted

\[ y_{i,t} = \beta_0 + \beta_1 x_{i,t} + e_{i,t} \]

- \( y_{i,t} \) the per-capita income by HH
- \( x_{i,t} \) a vector of HH characteristics
Evidence of Poverty Traps
Non-parametric Estimation of Asset Dynamics 1997-2006

Vera Chiodi (PSE & J-PAL)
Poverty traps in rural Mexico
November 13th, 2009 18 / 41
Key findings

HH can be converging to:

1. The poverty trap equilibrium (if asset index < 1.39 or 0.8 PLUs = a monthly per capita income of 38 US$)

2. Towards the stable equilibrium or the low equilibrium (if 1.39 < asset index < 2.1)

3. To a higher equilibrium (if asset index > 2.1 or 4.4 PLUs = a monthly per capita income of 199 US$)
## Assets Corresponding to the Cut-Off Levels of the Index:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Index = 1.39</th>
<th>Index = 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>years of education of the hh head</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>irrigation to land</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>electricity</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>earthfloor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>roof weak</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>animals</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>owned house</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>use of agricultural land</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ownership of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>refrigerator</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>gas stove</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>radio</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TV</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>washing machine</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>vehicles</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
A fixed effect in the regression of income on assets is predicted $\hat{\eta}_i$

$$y_{i,t} = \beta_0 + \beta_1 x_{i,t} + \eta_i + e_{i,t}$$

- $\eta_i$ time-invariant HH level unobserved heterogeneity

- Split the distribution function of the FE in two cut-offs & re-run lowess estimator
Evidence of Poverty Traps

Low and High *ability* HH

2,2 PLUs corresponds to a monthly per capita income of 98 US$
Confidence Intervals

![Graph showing confidence intervals]

- **Asset Index** vs. **Lagged Asset Index**
- Lines represent:
  - Lowess
  - 45° line
  - Lower & upper bounds

Title: Evidence of Poverty Traps by Vera Chiodi (PSE & J-PAL)

Date: November 13th, 2009
Evidence of Poverty Traps

Linear Partial Regressions

Full Sample (left) & High-ability Sample (right)
Kernel-weighted Local Polynomial Smooth

Full Sample (left) & High-ability Sample (right)

Degree: 3

Asset Index
0 0.5 1 1.5 2 2.5
Lagged Asset Index
0 0.5 1 1.5 2 2.5

Degree: 3

Asset Index
0 0.5 1 1.5 2 2.5
Lagged Asset Index
0 0.5 1 1.5 2 2.5
Evidence of Poverty Traps

Vera Chiodi (PSE & J-PAL)

Poverty traps in rural Mexico
Generating process of the asset position is:

\[ A_{i,t}^* = \beta_0 + \beta_1 A_{i,t-1}^* + \beta_2 (A_{i,t-1}^*)^2 + \beta_3 (A_{i,t-1}^*)^3 + \alpha_i + \mu_{i,t} \]  \hspace{1cm} (1)

If the asset index map is over the 45° line, non convexities doesn’t imply PT.

Condition that the derivative:

\[ g_i(A_{i,t-1}^*)|_{A_{i,t}^*=A_{i,t-1}^*} > 1 \]  \hspace{1cm} (2)

Must be evaluated in the roots of the equation (1)
Evidence of Poverty Traps

GMM Estimation of equation (1)

Three specifications (linear, quadratic and cubic):

\[
\begin{array}{cccc}
\beta_1 & -0.133 & -1.006 & -0.671 \\
& (-2.74)*** & (-11.12)*** & (-7.39)*** \\
\beta_2 & 0.927 & 0.791 \\
& (14.60)*** & (5.38)*** \\
\beta_3 & -0.092 \\
& (-1.09)*** \\
\end{array}
\]

Observations 8,730 8,730 8,730

The map of assets cuts the line of 45° from below

<table>
<thead>
<tr>
<th>Lineal specification</th>
<th>Quadratic specification</th>
<th>Cubic specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution (1)</td>
<td>Solution (1)</td>
<td>Solution (1)</td>
</tr>
<tr>
<td>0.74</td>
<td>-0.133</td>
<td>1.53</td>
</tr>
<tr>
<td></td>
<td>Derivative (2)</td>
<td>Derivative (2)</td>
</tr>
<tr>
<td>-0.133</td>
<td>1.824</td>
<td>2.19</td>
</tr>
<tr>
<td></td>
<td>(1) Solution of equation (1).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2) Derivative of the polynomial evaluated in the solution.</td>
<td></td>
</tr>
</tbody>
</table>
Plan

1. Introduction
2. The Data
3. Evidence of Poverty Traps
4. Conclusion
Empirical evidence of multiple equilibria
- Substantial minimum level of asset holdings is necessary to escape from the low equilibrium
- Heterogeneity across HH: *intrinsic characteristics* results: a particular intervention to change the fundamentals

Results
- Stable equilibrium around a low level of 80% PL
- Second equilibrium: we suggest that the HH will converge to the higher equilibrium (slope > 1)
Thank you!
HH Years of Education Dynamics, by type of HH

Education Dynamics for HH Migrant

Education Dynamics for Non-migrant HH

Locally weighted regression Line of 45°

bandwidth = .08
Basic Regressions: Assets

\[ A_{it} = \alpha_1 A_{i,t-1} + \alpha_2 A_{i,t-1}^2 + \alpha_3 A_{i,t-1}^3 + \alpha_4 A_{i,t-1}^4 \]  

(3)

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Animals</th>
<th>(2) Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag</td>
<td>0.510***</td>
<td>0.242***</td>
</tr>
<tr>
<td></td>
<td>(0.0413)</td>
<td>(0.0661)</td>
</tr>
<tr>
<td>Lag (squared)</td>
<td>-0.0600***</td>
<td>-0.00747**</td>
</tr>
<tr>
<td></td>
<td>(0.0146)</td>
<td>(0.00319)</td>
</tr>
<tr>
<td>Lag (cubic)</td>
<td>0.00278**</td>
<td>6.98e-05*</td>
</tr>
<tr>
<td></td>
<td>(0.00122)</td>
<td>(3.80e-05)</td>
</tr>
<tr>
<td>Lag (4th degree)</td>
<td>-4.45e-05</td>
<td>-1.94e-07</td>
</tr>
<tr>
<td></td>
<td>(2.88e-05)</td>
<td>(1.19e-07)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.274***</td>
<td>2.119***</td>
</tr>
<tr>
<td></td>
<td>(0.0116)</td>
<td>(0.199)</td>
</tr>
<tr>
<td>Observations</td>
<td>8730</td>
<td>8730</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.092</td>
<td>0.071</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses
Remittance income corresponds to 0.72 PLUs
Asset Dynamics for HH without Migrants

Vera Chiodi (PSE & J-PAL)
Poverty traps in rural Mexico
November 13th, 2009
Asset Dynamics for HH with Migrants, by level of ability

Migrant HH: low level (<=50th percentile)

Migrant HH: high level (> 50th percentile)

Locally weighted regression Line of 45º
bandwidth = .05

Vera Chiodi (PSE & J-PAL)
Asset Dynamics for HH without Migrants, by level of ability

Non-migrant HH: low level (<=50th percentile)

Non-migrant HH: high level (> 50th percentile)
Nonparametric regression curve using Lowess, as well as an OLS cubic regression curve

(A. Colin Cameron and Pravin K. Trivedi; Microeconometrics - Methods and applications)
Three-wave-average incomes and their compositions, by wave 1 hh type

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Head indigenous</th>
<th>Female head</th>
<th>Work adults per hh &gt; 2</th>
<th>Head age 65+</th>
<th>Hh diversif. &gt; 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total hh income</strong></td>
<td>21,245.17</td>
<td>17,564.39</td>
<td>15,244.07</td>
<td>27,894.59</td>
<td>15,653.60</td>
<td>28,638.77</td>
</tr>
<tr>
<td><strong>Source as % of hh inc.:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td>34.4</td>
<td>34.8</td>
<td>25.2</td>
<td>36.0</td>
<td>30.1</td>
<td>30.5</td>
</tr>
<tr>
<td>Non-agricultural</td>
<td>28.4</td>
<td>25.1</td>
<td>30.1</td>
<td>29.1</td>
<td>20.7</td>
<td>35.6</td>
</tr>
<tr>
<td>Self-employment</td>
<td>13.2</td>
<td>17.5</td>
<td>15.0</td>
<td>12.2</td>
<td>15.1</td>
<td>13.7</td>
</tr>
<tr>
<td>Transfers</td>
<td>15.7</td>
<td>12.0</td>
<td>22.1</td>
<td>15.4</td>
<td>25.8</td>
<td>9.3</td>
</tr>
<tr>
<td>Other</td>
<td>8.3</td>
<td>10.6</td>
<td>7.7</td>
<td>7.3</td>
<td>8.3</td>
<td>10.8</td>
</tr>
</tbody>
</table>
Years of education of the HH head by level of ability

Vera Chiodi (PSE & J-PAL)