Differential Effects of Food Security Policies on Subsistence Farmers and the Urban Poor

Francis M. Mulangu
Mario J. Miranda
Don F. Larson
Katie Farrin

African Center for Economic Transformation, The Ohio State University, The World Bank,
US Department of Agriculture Economic Research Service

Presented at African Economic Conference, Abuja, Nigeria
December 6, 2016
High, volatile food prices in recent years have...led to export restrictions among food exporters...revived interest among food importers in buffer stock programs

Recent World Bank research has examined MENA region, Senegal.

Wish to extend research to compare welfare implications of:

- buffer stock reserves (rural and urban)
- temporary export bans
- domestic transportation infrastructure enhancements
- port infrastructure enhancements
- agricultural index insurance
- direct cash transfers

Specific interest in effects on rural v. urban poor.

Specific interest in effects on exporting v. importing countries.
Model

- Stylized dynamic heterogeneous agent model of developing country.
- Country exposed to food production and world food price risk.
- Country divided into a rural “interior” and urban “port”.
- Country includes poor, food-insecure rural “farmers”.
- Country includes poor, food-insecure urban “laborers”.
- Food-insecure subsist on staple food commodity “grain”.
- Suffer “malnutrition” if resources cannot meet grain needs.
**Figure:** Flow of Grain Among Markets, Producers, and Consumers.
Inhabited by poor farmers, commercial farmers, non-poor consumers.

Typical poor farmer must consume $q^*$ to be well-nourished.

Farmer begins with pre-determined production $q_f$ and savings $s_f$.

If on-farm grain production exceeds needs, farmer sells surplus.

If production falls short, farmer uses savings to purchase grain.

Farmer malnourished if production + savings cannot meet requirement.
Let $p_r$ denote grain price in rural interior.

Farmer malnourished if

$$q_f + s_f/p_r < q^*$$

Farmer effective demand is

$$d_f = \min\{q^*, q_f + s_f/p_r\}$$

Farmer net change is cash holdings is

$$\Delta s_f = \max\{p_r(q_f - q^*), -s_f\}.$$ 

Fixed marginal propensity to save from cash holdings.
Poor farmers experience distinct, idiosyncratic production shocks:

\[ q_f = q \cdot \epsilon_f \]

where \( q \) is per-capita grain production and \( \epsilon_f \) is idiosyncratic shock.

Number of farmers large, idiosyncratic shocks fully diversifiable.

If \( F_f(s) \) is distribution of savings among poor farmers, then

\[ D_f(p_r) = \int E_\epsilon \min\{q^*, q\epsilon + s/p_r\} dF_f(s), \]

is aggregate demand for grain among poor farmers.
Figure: Poor Farmer Per-Capita Demand
**Figure**: Price and Poor Farmer Malnutrition
Inhabited by food-insecure laborers and food-secure consumers.

Typical laborer must consume $q^*$ to be well-nourished.

Laborer begins with pre-determined income $y_l$ and savings $s_l$.

Laborer uses income and savings to purchase grain.

Laborer malnourished if income+savings cannot meet requirement.
Let $p_u$ denote grain price in urban port.

Laborer malnourished if

$$y_l + s_l < p_u q^*$$

Laborer effective demand is

$$d_l = \min\{q^*, \frac{y_l + s_l}{p_u}\}$$

Laborer net change is cash holdings is

$$\Delta s_l = \max\{y_l - p_u q^*, -s_l\}.$$ 

Fixed marginal propensity to save from cash holdings.
Poor laborers experience distinct, idiosyncratic income shocks:

\[ y_l = y \epsilon_l \]

where \( y \) is per-capita income and \( \epsilon_l \) is idiosyncratic shock.

Number of laborers large, idiosyncratic shocks fully diversifiable.

If \( F_l(s) \) is distribution of savings among poor laborers, then

\[ D_l(p_u) = \int E_\epsilon \min\{q^*, \frac{y \epsilon + s}{p_u}\} dF_l(s), \]

is aggregate demand for grain among poor laborers.
Figure: Poor Laborer Per-Capita Demand
Figure: Price and Poor Laborer Malnutrition
Urban port linked to rural interior and world markets via a capacitated transportation network with fixed unit costs.

Equilibrium requires absence of spatial arbitrage profit opportunities and material balance.

Framework allows us to examine
- enhancement of domestic transportation infrastructure
- expansion of port facilities
- import and export tariffs and quotas.
## Model Parameters

**Table: Base-Case Parameter Values**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normalized Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>$q^*$</td>
<td>Per-capita grain consumption requirement</td>
</tr>
<tr>
<td>$\bar{P}$</td>
<td>Mean world grain price</td>
</tr>
<tr>
<td><strong>Farmer Production Distribution</strong></td>
<td></td>
</tr>
<tr>
<td>$\bar{q}$</td>
<td>Mean per-capita grain production, poor farmer</td>
</tr>
<tr>
<td>$\sigma_q$</td>
<td>Volatility, idiosyncratic production shock</td>
</tr>
<tr>
<td><strong>Laborer Income Distribution</strong></td>
<td></td>
</tr>
<tr>
<td>$\bar{y}$</td>
<td>Mean per-capita income, poor laborer</td>
</tr>
<tr>
<td>$\sigma_y$</td>
<td>Volatility, idiosyncratic income shock</td>
</tr>
</tbody>
</table>
**Table: Base-Case Parameter Values**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aggregate Supply and Demand</strong></td>
<td></td>
</tr>
<tr>
<td>$\bar{Q}$</td>
<td>Mean total grain production</td>
</tr>
<tr>
<td>$\bar{C}_f$</td>
<td>Mean total grain consumption, poor farmers</td>
</tr>
<tr>
<td>$\bar{C}_r$</td>
<td>Mean total grain consumption, non-poor rural</td>
</tr>
<tr>
<td>$\bar{C}_l$</td>
<td>Mean total grain consumption, poor laborers</td>
</tr>
<tr>
<td>$\bar{C}_u$</td>
<td>Mean total grain consumption, non-poor urban</td>
</tr>
<tr>
<td><strong>Non-Poor Demand</strong></td>
<td></td>
</tr>
<tr>
<td>$\alpha_r$</td>
<td>Rural non-poor excess demand scale factor</td>
</tr>
<tr>
<td>$\alpha_u$</td>
<td>Urban non-poor excess demand scale factor</td>
</tr>
<tr>
<td>$\beta_r$</td>
<td>Rural non-poor demand elasticity</td>
</tr>
<tr>
<td>$\beta_u$</td>
<td>Urban non-poor demand elasticity</td>
</tr>
</tbody>
</table>
### Table: Base-Case Parameter Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Savings</strong></td>
<td></td>
</tr>
<tr>
<td>$\rho_f$</td>
<td>Marginal propensity to save, poor farmer</td>
</tr>
<tr>
<td>$\rho_l$</td>
<td>Marginal propensity to save, poor laborer</td>
</tr>
<tr>
<td><strong>Transportation and Trade</strong></td>
<td></td>
</tr>
<tr>
<td>$\bar{X}_{ru}$</td>
<td>Maximum shipments, rural to urban</td>
</tr>
<tr>
<td>$\bar{X}_{ur}$</td>
<td>Maximum shipments, urban to rural</td>
</tr>
<tr>
<td>$\bar{X}_{uw}$</td>
<td>Maximum shipments, urban to world</td>
</tr>
<tr>
<td>$\bar{X}_{wu}$</td>
<td>Maximum shipments, world to urban</td>
</tr>
<tr>
<td>$\tau_{ru}$</td>
<td>Unit shipment cost, rural to urban</td>
</tr>
<tr>
<td>$\tau_{ur}$</td>
<td>Unit shipment cost, urban to rural</td>
</tr>
<tr>
<td>$\tau_{uw}$</td>
<td>Unit shipment cost, urban to world</td>
</tr>
<tr>
<td>$\tau_{wu}$</td>
<td>Unit shipment cost, world to urban</td>
</tr>
</tbody>
</table>
Figure: Effects of Aggregate Domestic Grain Production on Malnutrition
Figure: Effects of World Grain Price on Malnutrition
Figure: Effects of Per-Capita Urban Laborer Income on Malnutrition
Figure: Effects of World Grain Price on Financial Aid and Malnutrition
Figure: Effects of Domestic Grain Production on Financial Aid and Malnutrition
Figure: Effects of Urban Laborer Income on Financial Aid and Malnutrition
Figure: Effects of World Grain Price on Food Aid and Malnutrition
**Figure:** Effects of Domestic Grain Production on Food Aid and Malnutrition
Figure: Effects of Urban Laborer Income on Food Aid and Malnutrition
Next Steps

- Basic model implemented numerically.
- Next will simulate generic model under different policy regimes.
- Focus on effects of policy on malnutrition in urban and rural poor.
- Parameterize model to fit specific case (MENA, Senegal, Ghana?).
- Draw empirical implications and put model to empirical tests.