Agricultural Trade Liberalization, Productivity Growth and Poverty Alleviation: A Dynamic General Equilibrium Analysis

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Goals

- Investigation of the impact of agricultural trade liberalization on poverty and equity in Tunisia.
- Estimation of the long run poverty effects of trade reforms with a dynamic CGE model incorporating econometric estimation of the productivity linkage and imperfect competition.
The signing of the partnership agreement with the European Union (EU).

While currently limited to the removal of tariff and non-tariff barriers on manufactured goods, the arrangements are expected to be enlarged to farm products.

Agriculture carries heavy weight in terms of employment and represents an important foundation in the Tunisian economy both as a source of foreign exchange earnings and as the mean of ensuring food security.
The openness process is likely to have a profound impact on the agricultural development and poverty in Tunisia as it is expected to induce significant effects on price, income and incentives for investment and adoption of new technology.
Research Objectives

The economic linkages among agriculture, trade and poverty are complex. The recent literature documented several channels through which trade affects growth and poverty:

- changes in commodity and factor prices,
- changes in income and employment,
- increased competition,
- access to improved technology.
Research Objectives

Seeking a better understanding of the link among poverty, economic growth, income distribution and trade is the main issue addressed in this project that we will try to develop as a pilot study providing all the explanation and the details needed for helping other research to implement the same approach in their respective country.
Main questions

- **What are the effects of trade openness on agricultural growth?**
  - Investigation of the key parameters that can serve as a basis for estimating dynamic agricultural productivity and efficiency gains from increased trade.
Main questions

The difficulty of empirically investigating this issue stems from:

- The difficulty of obtaining accurate measures of farming performance and factor inputs.
- The difficulty of obtaining a precise measure of agricultural protection including trade preferences, regional agreements, and various types of domestic support.
- The complexity of disentangling the direction of causality.
Main questions

- What are the linkages and pathways through which trade contributes to poverty alleviation?
  - Evaluation of the impact of trade liberalization effects on agricultural prices and of the extent of price changes transmission to the poor.
Main questions

Difficulties:

- Investigation of the supply chain and distribution channels,
- Evaluation of the transaction costs,
- Assessment of exchange rate distortions.
Main questions

- Assessing the impact of trade on factor prices and investigating the functioning of the labor market.

The structure and the functioning of the labor markets are critical to how trade effects get transmitted to wages and employment especially those of unskilled workers:
Main questions

- Trade reforms may boost the demand for labor-intensive products, it then may boost wages and employment.
- However, if the poor are mostly unskilled, while it is semi-skilled labor that receives the boost, poverty will be unaffected.
- It is also important to check where the various wage rates lie relative to the poverty line and whether wages cross critical thresholds to evaluate the poverty impacts.
Main questions

A special attention is devoted to investigating the joint relationship between trade, productivity and product differentiation, and to assessing the potential poverty impacts of this additional mechanism.
Main questions

Exposure to international trade stimulates technical change through:

- The diffusion of new technologies,
- Increased competitive pressures that help prompt domestic firms to improve their technologies.

With the fall of tariff barriers, quality assurance is likely to become the major constraint for international market access.
Main questions

Technology and productivity growth may have adverse effects on the economic conditions of the poor:

- Higher productivity may in the short term reflect declining inputs rather than increasing outputs.
- Technical change may be skill-biased.
Core Research Objectives

- Synthesizing the dynamic productivity effects of increased trade on poverty by combining the *econometrically* estimated productivity gains with an AGE analysis of trade liberalization.
- Providing guidance for the necessary complementary policies that can make trade policy reform more effective in *poverty alleviation*.
Scientific contribution of the research

Much of the research on poverty has particularly focused on the consumption side of the trade-poverty linkages and neglected the factor markets as well as the long-run productivity mechanisms.
Scientific contribution of the research

- Porto (2003) and Nicita (2004) used a general equilibrium approach to estimate the impact on wages of potential changes in domestic commodity prices arising from trade reforms in Argentina and Mexico.

- These analyses ignored however the additional dynamic productivity effects induced by trade on product and factor prices.
Scientific contribution of the research

- Coxhead and Warr (1995) and De Janvry and Sadoulet (2001) explored the implications of agricultural technology adoption on poverty.

- While these analyses underscored the critical role of factor markets when examining the poverty impacts of external shocks, these are not a trade liberalization studies.
Scientific contribution of the research

- Cline (2004) included econometrically estimated productivity gains from increased trade in a CGE analysis of the global poverty implications of trade liberalization. Anderson et al. (2005) also considered the productivity effects in the World Bank LINKAGE model.

- These productivity effects are off-line calculations.
Methodology

The methodology is based on two distinct approaches:

- An **econometric** investigation of the relationship between trading, agricultural productivity and product quality.

- A **CGE** analysis of the macroeconomic implications of the agricultural trade openness.
Trade, Efficiency and Quality in the agricultural sector

A partial equilibrium approach to assess the contribution of trade openness to the Tunisian agricultural performance.

Evaluation of product quality and efficiency scores:

- Efficiency scores are assessed using the latent class stochastic frontier modeling approach and the metafrontier concept.
- Product quality measures are inferred from market shares and unit-value trade data using a discrete choice framework.
**Agricultural Productivity Measurement: LCSF Model**

Assume a latent sorting of the producers into $J$ discrete unobserved groups, each using a different production technology:

$$
\ln(y_{it}) \mid j = \ln f(x_{it}, \beta_j) \mid j + \nu_{it} \mid j - u_{it} \mid j
$$
The unconditional likelihood for country $i$ is obtained as a weighted average of its $j$-class likelihood functions, with the probabilities of class membership used as the weights:

$$LF_i = \sum_{j:1}^{J} LF_{ij} P_{ij}$$
Agricultural Productivity Measurement: LCSF Model

- Using the parameters estimates and Bayes' theorem, we compute the conditional posterior class probabilities from:

\[
P_{j|i} = \frac{LF_{ij}P_{ij}}{\sum_j LF_{ij}P_{ij}}
\]

Country \( i \) is classified into group \( k ( : 1, ..., J) \):

\[
P_{k|i} = \max_j P_{j|i}
\]
Agricultural Productivity Measurement: LCSF Model

\[ \ln TE_{it} = \sum_{j:1}^{J} P_{j|i} \ln TE_{it|j} \]

\[ \text{TFP}_i|_j = y_i|_j - x_i = \frac{(\varepsilon|_j - 1)}{\varepsilon|_j} \sum_k \varepsilon_k|_j x_k + \frac{\partial \ln(f(x_i, \beta_j)|_j)}{\partial t} - \]

\[ \sum_h \frac{\partial g(ln z_i, \delta_j)}{\partial \ln(z_{ih})} z_i \omega_i|_j - g(ln z_i, \delta_j) \frac{\partial \omega_i|_j}{\partial t} \]
Agricultural Productivity Measurement: LCSF Model

\[ TFP_i = \sum_{j:1}^{J} P_{j|i} TFP_{i|j} \]

We use the estimated country-specific frontiers to construct the metafrontier function that envelops all the individual technologies and which is expressed by:

\[ y_{it}^* = f(x_{it}, \beta^*) = \max_j f(x_{it}, \beta_j) \mid_j \]

\[ TGR_{jt} = \frac{f(x_{it}, \beta_j) \mid_j}{f(x_{it}, \beta^*)} \]
Quality Measurement

- The quality estimates are recovered from prices and market shares using a discrete choice model of product differentiation.
- Products are grouped in sets of goods of similar characteristics.
- Each product set $g: 1\ldots G$ is comprised of several varieties denoted by $j: 1\ldots J_g$.
- We consider $I$ trading countries, indexed by $i: 1\ldots I$, producing and exporting product $j$.
- The indirect utility of consumer $n$ from buying product $j$ belonging to group $g$ is:
Quality Measurement

\[ u_{nij} = \delta_{ij} + \zeta_{nig} + \varepsilon_{nij} \]

\[ \delta_{ij} = \xi_{ij} - \alpha p_{ij} \]

\[ \log(s_{ij}) - \log(s_0) = -\alpha p_{ij} + \sigma \log(s_{ij}/g) + \xi_{ij} \]
Macroeconomic and distributional implications of agricultural trade openness

A dynamic sequential general equilibrium approach including imperfect competition and product differentiation.

- 38 production sectors:
  - 25 agricultural and food activities,
  - 13 urban industries and services.

- Factors of production are: capital, land, labor and natural resources:
  - Land is differentiated according to the perennial features of the crops and the irrigation intensity.
  - Labor is classified by the level of qualification and the degree of geographical mobility.
Macroeconomic and distributional implications of agricultural trade openness

- Institutions include households, companies, government and foreign trading partners.
  - The household bloc is desegregated into nine groups including rural and urban households.
  - The trading partners are decomposed into European Union countries and rest of the world.
The model structure

- Production structure:

  The model’s production functions are of the nested structure:
  - VA is a CD function of labor, land, capital and natural resources.
  - Labor is a CES bundle of skilled and unskilled labor.
  - Land is also decomposed by type in a CES nest.
  - Land is agriculture specific and labor is assumed to be fully mobile.
  - Capital and natural resources are assumed to be sector specific.
The model structure

- Oligopolistic competition is assumed to hold in the agricultural and manufacturing sectors where each producer supply distinct varieties with a fixed production cost for each product.
- Firms exert their market power by applying a mark-up to their marginal cost.
- This mark-up depends, according to the Lerner formula, on the price-elasticity of demand.
The model structure

- Production requires multiple factors of production whose intensity of use varies across industries. We assume that the cost function takes the following Cobb Douglas form:

\[
CT_i = F_i + \left( \frac{q_i}{A_i} \right) \prod_k w_k^{\beta_i^k}
\]
The model structure

- the equilibrium price of a product variety is a constant mark-up over marginal cost:

\[ p_i = \frac{\prod w_k^{\beta_i^k}}{\rho A_i} \]
The model structure

- Following Diao et al. (2005), we introduce labor augmenting technical progress $AL$, which is equal across the different sectors, and land augmenting technical progress $AD$.
- Total factor productivity is then expressed as:

$$A_i = A_L^{\beta_i^L} A_D^{\beta_i^{LD}}$$
The model structure

Factors demand may be expressed as:

$$x_{ki} = \beta_i^k (A_L)^{-\beta_j^L} (A_D)^{-\beta_j^D} (w_k)^{\beta_i^k} \prod_{h} w_h^{\beta_i^h}$$
The model structure

- **Demand structure:**
  - Preferences across sectors are represented by the LES (Linear Expenditure System) function.
  - The consumption choices within each sector are a nesting of CES functions.
  - The subutility specifications are an augmented version of the Dixit-Stiglitz structure of preferences.
The model structure

- the upper tier of utility determining consumption of the different goods is LES and that the lower tier of utility determining consumption of varieties takes the CES form,

\[ U = \prod_{i} (C_i - C_{\text{min}i})^{\alpha_i} \]
The model structure

\[ C_i = \left[ \int_{\omega \in \Omega_i} (\theta_i(\omega) q_i(\omega))^\rho \, d\omega \right]^{\frac{1}{\rho}} \]

\[ P_i = \left[ \int_{\omega \in \Omega_i} \left( \frac{p_i(\omega)}{\theta_i(\omega)} \right)^{1-\sigma} \, d\omega \right]^{\frac{1}{1-\sigma}} \]
The model structure

The optimal consumption and expenditure decisions are given by

\[ q_i(\omega) = (\theta_i(\omega))^{\sigma^{-1}} \left( \frac{p_i(\omega)}{P_I} \right)^{-\sigma} Q_I \]

\[ r_i(\omega) = (\theta_i(\omega))^{\sigma^{-1}} \left( \frac{p_i(\omega)}{P_I} \right)^{1-\sigma} R_I \]
Productivity dynamics

- Following Rattsø and Stokke (2005) we assume the labor augmenting productivity growth rate to depend on innovation activities, human capital, and foreign trade:

\[
\hat{A}_L = \left( \frac{I}{GDP} \right)^{\alpha_1} + \lambda (H)^{\alpha_2} \left( \frac{TRADE}{GDP} \right)^{\alpha_3} (1 - TGAP)
\]
Productivity dynamics

- As increased openness may lead to skill biased productivity growth, we investigate this effect through the following CES specification of aggregate labor demand.

- Following Rattsø and Stokke (2005) aggregate labor demand is specified as:

\[
L_i = \left[ \gamma_{1,i} A_L^{\rho_l-1/2\beta} U L^{\rho_l} + \gamma_{2,i} A_L^{\rho_l+1/2\beta} S L^{\rho_l} \right]^{1/\rho_l}
\]
The reduced form specification of technological bias is assumed to be an increasing and convex function of adoption relative to innovation:

\[ \beta = \alpha \left( \left( \frac{TRADE}{I} \right)^2 - 1 \right) \]
Productivity dynamics

- Land augmenting technical progress is simply related to international trade:

\[ A_D = \gamma \text{ TRADE} \]
Productivity dynamics

- The proportional change in factor demand is affected by productivity variation in the following way:

\[ \hat{x}_{ki} = \hat{q}_i + \left( \beta^k_i - 1 \right) \hat{w}_{ki} + \sum_{h \neq k} \beta_h \hat{w}_{hi} - \sum_h \beta^h_i \hat{A}_{hi} \]
Income distribution and poverty

- We follow Decaluwé et al. (1999), by adopting specific intra-group income distributions, and by endogenizing the poverty line and the resulting poverty incidence among the different socioeconomic household groups.

\[ P = P(Y, L(p)) \]
Income distribution and poverty

- $P$ denotes the poverty measure which we assume to belong to the Foster-Greer-Thorbecke class (1984):

\[
P_{\theta} = \int_{0}^{z} \left( \frac{z - y}{z} \right)^{\theta} f(y) dy
\]
### Some Very Preliminary Results

<table>
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<tr>
<th></th>
<th>Fruits</th>
<th>Citrus</th>
<th>Shell</th>
<th>Veget.</th>
<th>Cereals</th>
<th>Pulses</th>
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